Famous Photographers Course

Famous Photographers Course
Technical Manual

Famous Photographers Course Technical Manual

A concise reference handbook
of useful technical information
for photographers

Prepared exclusively for students of the
Famous Photographers School
Westport Connecticut

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Famous
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Technical
Manual

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Famous
Photographers School

About this book

The Famous Photographers Course Technical Manual can be a valuable aid in helping you successfully complete your Course–and in the photography you do later. We have included here, in concise, easy-to-use form, basic facts about the materials, equipment, and methods of modern still and motion-picture photography. The charts, tables, and explanations can help you solve many of the technical problems you may encounter in picture-taking, and assist you in applying things you learn in your lessons.

This manual is designed to supplement your Course textbooks. As you read your lessons, you'll find references to the manual. We urge you to look up these references and study them–they can enrich your understanding, and help you increase your skill and avoid errors.

We have not planned your manual as a complete reference book on all the technical aspects of photography–that would take many thick volumes. But we have gathered and arranged for you the kind of technical information that is most frequently needed by serious amateur and professional photographers. You have it handy, all in one place, for quick and convenient reference.

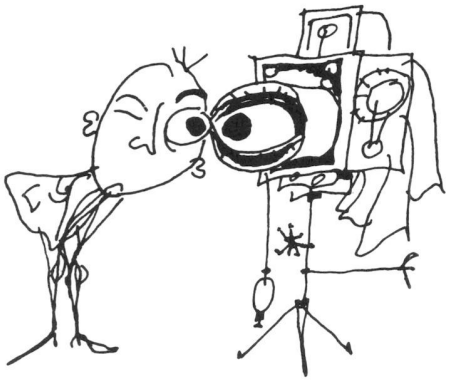
The information given here is as up-to-date as we can make it. However, the technology of photography is growing and changing at a fast rate, with new cameras, films, developers, and mechanical and electronic devices appearing on the market almost constantly. To keep up with the very latest innovations, we suggest you read the reports in current photographic magazines and manufacturers' literature.

We produced your manual in loose-leaf form to make it easy for you to add to it technical or reference material you clip from current photographic publications or acquire from manufacturers. Just punch holes in any sheets or pages you want to add, and insert them in the appropriate section. Thus your manual can continuously increase in usefulness as time goes on.

The technical side of photography–its equipment, materials, and their use–is fascinating and important. However, it's wise to keep it in proper perspective. It is a *means* to an end–creating good pictures. The purpose of this manual is to help you use the basic tools of photography to achieve this goal.

1

Basic facts about lenses



The lens is the "eye" of your camera–in some respects its most vital part. Understanding a few basic facts about lenses can help you use your lens more effectively to get the results you want. In this section, we'll concentrate on two important practical characteristics of any lens–its speed and its focal length. Although it is possible to take pictures without concerning yourself with these matters, the more refined creative picture controls we teach in your Course do require that you have a working knowledge of what an *f* stop is and what effect it has on a picture, and how focal length can be used in controlling image size and perspective. So let's take a closer look at these important subjects.

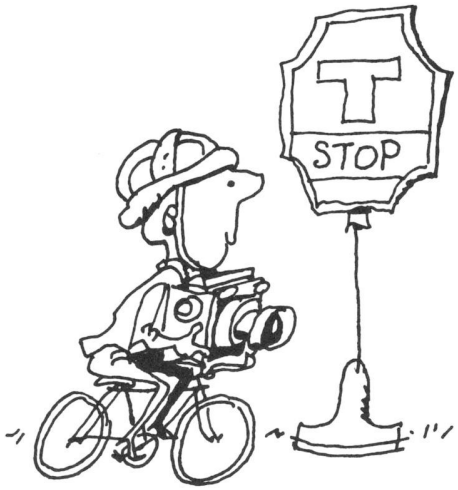
The meaning of *f* numbers

The speed of a lens–its ability to transmit light–usually is given as an *f* number. An *f* number indicates a *ratio* or *proportion* between the effective diameter of the lens opening and the focal length of the lens. [The effective diameter simply means the width of the beam of light that the lens opening admits to the camera.] A setting of *f*/2, for example, tells us that the lens opening is half the focal length. A setting of *f*/8 means the lens opening is only one eighth the focal length, etc.

The thing about *f* numbers that sometimes confuses beginners is that a high *f* number, *f*/32, for example, indicates a small opening, while a low *f* number, such as *f*/4, indicates a large opening.

This confusion ought to disappear if you think of *f* numbers as fractions in which the numerator [the number above the line] always is one and the denominator [the number below the line] is the indicated number. Thus, think of *f*/32 as 1/32 and *f*/4 and as 1/4. Obviously, 1/32 is less than 1/4 and indicates a smaller lens opening that admits less light.

Another point to remember–an *f* number is a *relative* figure. It tells us the proportion between the lens opening and focal length of a particular lens; it



does *not* tell us the actual size of the lens opening as measured by a ruler. For example, the effective opening of an *f*/4 lens on a 35-mm camera would only measure about 1/2 inch in diameter, but the effective opening of an *f*/4 lens on a view camera might measure about 2 inches across. Yet, in theory, both would deliver exactly the same amount of light to the film if pointed at the same subject.

In practice, this may not always be true. Some light may be lost in passing through a lens by being reflected from the surfaces of the lens components. Therefore, lenses of different make or design may vary somewhat in their ability to transmit light even though they have the same *f* number.

A system called *T-stops* [short for transmission stops] sometimes is used to take into account any discrepancy between the theoretical performance of a lens and its actual ability to transmit light. T-stops are *f* numbers based on the amount of light the lens actually transmits at its various aperture settings. They always will be slightly higher than corresponding standard *f* numbers.

The difference between T-stops and standard stops is not usually considered important in still photography, and most still camera lenses are not marked in the T-stop system. However, T-stops are frequently used in professional motion-picture cameras.

How to interpret the markings on a lens mount

The focal length of a lens and its largest opening usually are marked on the lens mount. The markings may look something like this: John Doe Astigmatar 5-inch *f*/2.8. This identifies the lens as an Astigmatar [brand name of this particular design] manufactured by the John Doe Company, with a focal length of 5 inches and a widest aperture of *f*/2.8. [When we talk about an *f*/2.8 lens or an *f*/6.3 lens we mean that *f*/2.8 or *f*/6.3 is the largest aperture the lens can give us–it's the speed of the lens "wide open."]

In the case of a European lens, the lens markings might look something like this: John Doe Astigmatar f=125: 1:2.8. Here the small "f" stands for focal length, which is given in millimeters. In other words, the focal length equals 125 mm. The 1:2.8 marking shows the proportion of the focal length to the lens' widest aperture; read it as meaning *f* [with the lens wide open] equals 2.8.

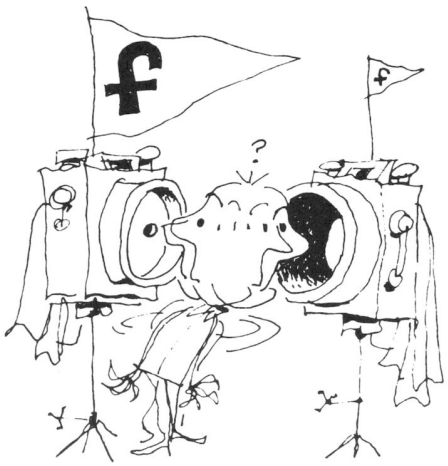
The full range of *f* stops

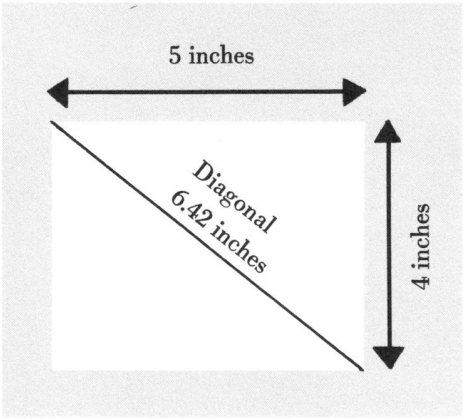
On some cameras you may encounter one or more *f* stops that are unfamiliar to you. On some older makes of European cameras, in particular, you may find a different sequence of *f* numbers than the ones you are accustomed to using. The accompanying chart shows three sequences of *f* numbers. [The column on the left is the sequence most commonly found on current camera models.] The horizontal lines indicate differences in light-transmitting ability of one-third stop.

The chart will quickly show you the relationship of any *f* number to any other *f* number in the same sequence or in another sequence. For example, *f*/2.2 is one third of a stop less than *f*/2, but two thirds of a stop greater than *f*/2.8; *f*/18 is a full stop less than *f*/12.5, etc. When there is less than one third of a stop difference between two *f* numbers, such as with *f*/2.8 and *f*/2.9, we've put them together. Such minor differences are negligible in ordinary photography, and for practical purposes the *f* numbers can be considered identical in value.

Table of *f* numbers

1		
	1.1	
		1.2 [1.3]
1.4 [1.5]		
	1.6	
		1.8
2 [1.9]		
	2.2	
		2.5
2.8 [2.9]		
	3.2	
		3.5
4 [3.8]		
	4.5	
		5
5.6		
	6.3	
		7
8 [7.7]		
	9	
		10
11		
	12.5	
		14
16		
	18	
		20
22		
	25	
		28
32		
	36	
		40
45		
	48 [50]	
64		





Focal length

The focal length of a lens is the distance from the optical center of the lens to the film, when the lens' focusing control is set at *infinity*. [In practice, any object at a relatively great distance is considered to be at infinity.] For practical purposes, the diaphragm can be assumed to be at the optical center of lenses of normal construction.

From the practical, picture-taking standpoint, focal length is important for two reasons: [1] it determines the degree of image magnification the lens gives, and [2] it affects the angle of view covered by the lens.

Most cameras are fitted at the factory with a lens of "normal" focal length. Normal focal length is a relative term. It's usually defined as a focal length that is approximately the length of the diagonal of the negative area of the film in the camera. [See the accompanying chart for a list of the most commonly used negative sizes.] For example, the diagonal of a 4x5 sheet of film is 6.42 inches [see the diagram]. Therefore, a 6 1/2-inch lens is considered a normal lens *when used with 4x5 film.*

For various reasons of optical and mechanical design, normal lenses don't usually match the film diagonal exactly. For example, the diagonal of a standard 35-mm negative frame is 43.2 mm, but most 35-mm cameras are supplied with a normal lens of anywhere from about 45 mm to 58 mm. Normal focal lengths for 2 1/4x2 1/4 cameras [where the film has a diagonal of 80.8 mm] are 75 or 80 mm. See the charts on pages 5, 6, and 7 for additional information.

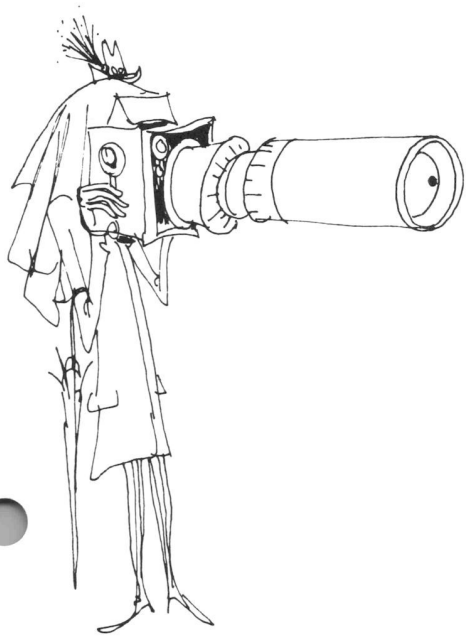
Diagonal of commonly used sizes of negatives for still cameras

Size of negative	Diagonal of negative area	
	inches	millimeters
24x36 mm [standard 35 mm]	1.70	43.2
28x40 mm [bantam-size film]	1.92	48.8
2 1/4x2 1/4 inches	3.18	80.8
2 1/4x3 1/4 inches	3.95	100.4
3 1/4x4 1/4 inches	5.35	136.0
4x5 inches	6.42	163.0
5x7 inches	8.58	218.0
8x10 inches	12.80	325.0
11x14 inches	17.80	452.0

Wide-angle lenses

If the focal length of a lens is substantially *shorter than normal*, it is said to be a wide-angle lens. It will give a smaller image but has a wider angle of view. Wide-angle lenses are particularly useful when you're shooting in cramped quarters where a normal lens wouldn't take in enough of the subject. They also are useful when you want to move close to your subject to get an effect of exaggerated perspective. [Examples of these uses are given in your text.]

Depending on the focal length and the size of the film used, wide-angle lenses may give a viewing angle of up to 100 degrees. Special lenses have been designed to include an angle of view of up to 180 degrees.



Long lenses

If the focal length of a lens is substantially *longer than normal*, it may be called a long lens, a long-focus lens, or [loosely] a telephoto lens. Strictly speaking, telephoto refers to a particular type of optical construction in which the focal length is longer than the actual physical length of the lens. All telephotos are long lenses–have a longer-than-normal focal length–but not all long lenses are true telephotos in their construction. So throughout the Course we've used the more general designation of long lens.

Long lenses give a larger image but cover a narrower angle of view than do lenses of shorter focal length. They are useful when a normal lens would give you too small an image of the subject from a certain shooting distance. They also are useful in portraiture and other situations when you want to shoot from a relatively great distance from the subject to minimize the effect of perspective. [These and other uses of long lenses are demonstrated in many of your lessons.]

Approximate diagonal angles of view of lenses for 2 1/4x2 1/4 cameras

Lens classification*	Focal length in millimeters	Diagonal angle of view in degrees
very wide angle	38	90
	50	75
wide angle	55	71
	60	67
	65	63
normal	75	54
	80	52

*These classifications are arbitrary and only for convenience in listing and comparing.

Lens angles of view for 2 1/4 x 2 1/4 cameras [*continued*]

Lens classification*	Focal length in millimeters	Diagonal angle of view in degrees
medium long	105	41
	135	33
	150	29
	180	25
extra long	250	18
	300	13.35
	400	10
	500	9

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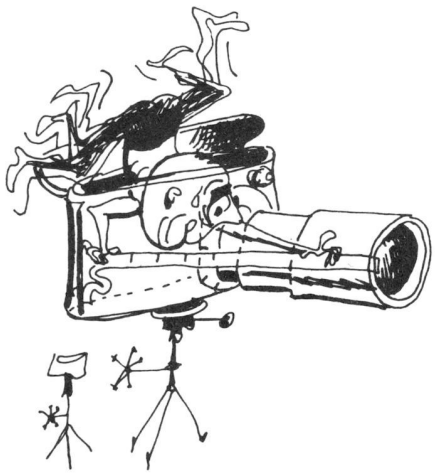

Approximate diagonal angles of view of lenses for 35-mm cameras

Lens classification*	Focal length in millimeters	Diagonal angle of view in degrees
very wide angle	21	91
	25	83
	28	76
wide angle	35	63
normal	45	52
	50	46
	58	41

*These classifications are arbitrary and only for convenience in listing and comparing.

Wide-angle lenses

If the focal length of a lens is substantially *shorter than normal*, it is said to be a wide-angle lens. It will give a smaller image but has a wider angle of view. Wide-angle lenses are particularly useful when you're shooting in cramped quarters where a normal lens wouldn't take in enough of the subject. They also are useful when you want to move close to your subject to get an effect of exaggerated perspective. [Examples of these uses are given in your text.]

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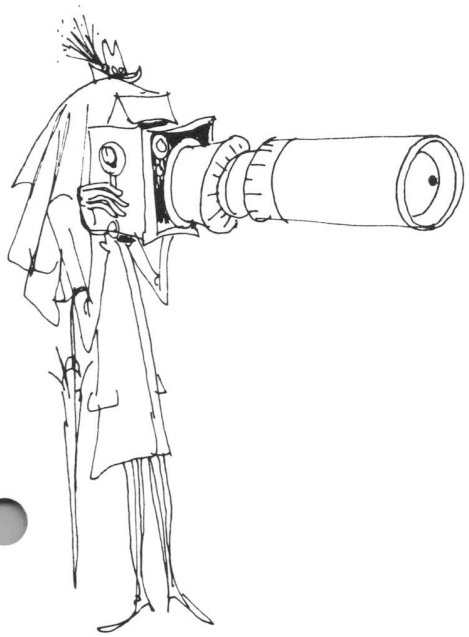

Long lenses

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Approximate diagonal angles of view of lenses for 2 1/4x2 1/4 cameras

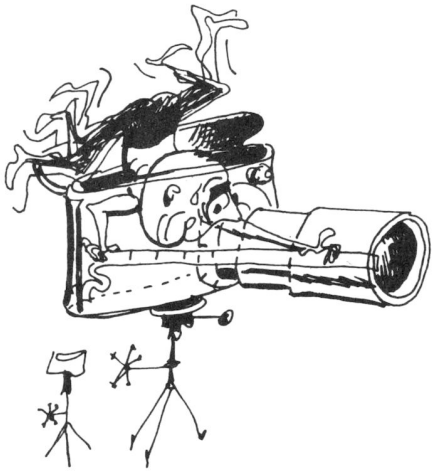
Lens classification*	Focal length in millimeters	Diagonal angle of view in degrees
very wide angle	38	90
	50	75
wide angle	55	71
	60	67
	65	63
normal	75	54
	80	52

*These classifications are arbitrary and only for convenience in listing and comparing.

Lens angles of view for 2 1/4 x 2 1/4 cameras [*continued*]

Lens classification*	Focal length in millimeters	Diagonal angle of view in degrees
medium long	105	41
	135	33
	150	29
	180	25
extra long	250	18
	300	13.35
	400	10
	500	9

*These classifications are arbitrary and only for convenience in listing and comparing.



Approximate diagonal angles of view of lenses for 35-mm cameras

Lens classification*	Focal length in millimeters	Diagonal angle of view in degrees
very wide angle	21	91
	25	83
	28	76
wide angle	35	63
normal	45	52
	50	46
	58	41

*These classifications are arbitrary and only for convenience in listing and comparing.

Lens angles of view for 35-mm cameras [*continued*]

Lens classification*	Focal length in millimeters	Diagonal angle of view in degrees
medium long	75	32
	85	28
	90	27
	105	23
long	125	20
	135	18
	150	16
extra long	180	14
	200	12
	300	8
very long	400	6
	500	5

*These classifications are arbitrary and only for convenience in listing and comparing.

Controlling image size

Here are some basic facts to keep in mind about controlling the size of the subject's image on your negative.

From any given shooting distance:

1. The *longer* the focal length of your lens, the *larger* the image of any object included in the picture.

2. The *shorter* the focal length, the *smaller* the image of any object included in the picture.

3. The size of the image is in direct [arithmetic] proportion to the focal length. For example, let's assume that from a given shooting distance a 100-mm [4-inch] lens produces an image of an object on the negative that is 2 inches high. If you use a 200-mm [8-inch] lens from that same shooting distance, it will record an image that's 4 inches high. If you use a 50-mm [2-inch] lens, it will give an image that is only 1 inch high, etc.

With any given lens:

Image size changes in direct [arithmetic] proportion to changes in lens-to-subject distance. For example, let's assume you are taking a picture of an object from a distance of 6 feet. The image on your negative measures 2 inches high. If, with the same lens, you move in to a shooting distance of 3 feet, the image will be 4 inches high. On the other hand, if you move back to 12 feet, the image will be reduced to only 1 inch, etc.

Therefore, to control the size of the image when you are taking a picture, do the following:

If the image is too small:

1. Move closer to the subject, *or*
2. Switch to a lens with a longer focal length. This is especially useful in candid shooting or other situations where you can't or don't want to move too close to the subject.

If the image is too large:

1. Move farther away from the subject, *or*
2. Switch to a lens of shorter focal length. This is particularly useful in cramped quarters where you can't back off far enough from your subject.

Important: No change in perspective takes place when you switch lenses *without changing your camera position.* But moving your camera closer to–or farther away from–your subject does cause a change in perspective. [See the demonstration of this in your lesson on scenic and travel photography.]

Depth of field

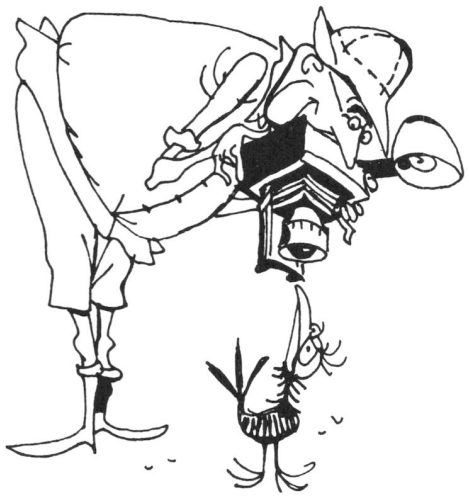
Depth of field is the distance between the nearest and the farthest objects that will *appear to be in sharp focus* in your picture. In the lesson on your camera and how it works, we gave some simple demonstrations of depth of field in very practical terms. Here is a more detailed discussion that you may find helpful in your more advanced work.

First, keep in mind that the sharpness of an image is a subjective thing to a degree. A picture [or a detail within a picture] may look satisfactorily sharp to one person but not to another, because of physical differences in their eyesight or because they have different standards of sharpness.

Your pictures must be satisfactorily sharp to you–or to your client. If you find that using the depth-of-field scale on your camera, or charts indicating depth of field, doesn't give pictures that are acceptably sharp by *your* standards, then you must interpret the figures in the scale or charts more strictly. For example, if the camera scale indicates that "everything will look sharp" within a range of 6 to 15 feet, you may find by experience it is necessary to keep within a range of only 4 to 10 feet all objects you want sharp.

Or you might use *one stop less* than the scale or table calls for. For example, to be sure of getting the depth of field indicated for *f*/8, you would set your lens opening at *f*/11.

It's also important to remember that we judge depth of field, or sharpness, as it appears in the final print or transparency. The more you enlarge a negative, the more any lack of sharpness will be magnified. An object that looks sharp in a 4x5 print, let us say, may appear quite fuzzy when blown up to a 16x20 size. Obviously, the distance from which you view the print or



transparency is a factor, too. The closer you are, the more noticeable any slight degree of unsharpness will be. [Keep in mind that depth-of-field tables are designed for use with a normal degree of enlargement and normal viewing distance.]

If you plan to make bigger-than-normal enlargements, you have to be very strict in the way you interpret depth-of-field charts and tables. You may have to assume, for your purposes, that depth of field is less than indicated, and use the "one stop less" method we have described.

Controlling depth of field

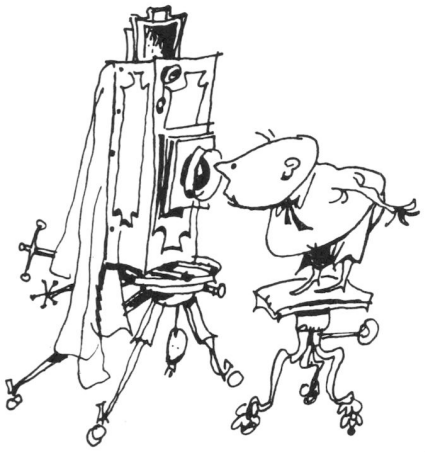
For the following discussion, we'll assume that in each case we give the negative exactly the same degree of enlargement, and that it's viewed from a normal distance by a person with normal eyesight and standards of sharpness.

Given these conditions, depth of field depends on two basic factors: [1] image magnification–how big the image of an object is *on the negative*–and [2] the *f* stop used. The smaller the image or the smaller the *f* stop, the greater the depth of field. The larger the image or the larger the *f* stop, the less the depth of field.

The most readily available control over depth of field usually is your lens aperture control. You stop down when you want more depth of field and open up when you want less. However, let's take a closer look at the other basic factor–image magnification–and see how that works.

Let's assume you leave your lens set at a given *f* stop. To obtain greater depth of field you need to reduce the size of the image on the film. You might do this by moving farther away from your subject, by switching to a lens of shorter focal length, or by doing a combination of both. On the other hand, if you want less depth of field, you need to make the image larger. To do this you could move closer to your subject, switch to a longer lens, or do a combination of both.

A look at your depth-of-field scale and a little experience with photography will drive home the importance of distance in controlling image size and therefore depth of field. At short distances, depth of field becomes relatively shallow, and you must focus with extreme care. When you're at a considerable distance from the subject, however, you may not even need to focus at all–in some cases you may be able to set your camera at infinity and let the great depth of field take care of the rest.



You can also use a shorter-than-normal lens for more depth of field, or a longer-than-normal one for less. Strictly speaking, the focal length of the lens doesn't have any effect on the depth of field. It's only the image magnification that a particular lens gives you at a particular shooting distance that counts.

For example, let's assume you set up two 35-mm cameras–one having a 50-mm lens and one a 100-mm lens. Let's say your subject is a person. If you placed the camera with the 50-mm lens 5 feet from the subject, and the camera with the 100-mm lens 10 feet from him, and set both lenses at the same *f* stop, *your depth of field would be identical in both pictures.* The reason is that the image magnification is identical. The long lens at the 10-foot distance gives exactly the same image size of your subject as the normal lens at the shorter distance.

In practice, of course, you're more likely to change lenses without changing your shooting distance. And *from the same shooting distance* a shorter lens, producing a smaller image, will give you greater depth of field than a longer one, which gives a bigger image. When you hear or read about the great depth of field of a wide-angle lens or the shallow depth of field of a telephoto lens, keep in mind that this applies *only in comparison with another lens focused on a subject at the same distance* [*and set at the same* f *stop*].

How depth of field shifts

The *distribution* of depth of field–how far in front of the subject it extends in comparison with how far behind–changes with the focusing distance. For example, if your camera lens is focused on a relatively distant subject, depth of field may extend several feet in front of the subject but run all the way to infinity behind it.

As you move closer, this proportion changes. At medium distances, the distribution is about one third in front of and two thirds behind the point of sharpest focus. This is a handy fact to keep in mind. For example, if you're focusing on a crowd and you want as many faces in sharp focus as possible, it might mean that you should not focus at a midpoint between the nearest and farthest person but only about one third of the way back.

As you focus on a subject that is even closer, the distribution gradually evens out, front and back. With a 50-mm lens at *f*/2, for example, depth of field runs about 2½ inches in front and 2½ inches behind a 5-foot focusing point. Finally, in extremely close work [with the subject at a distance of two focal lengths from the lens], distribution becomes exactly even–one half in front and one half behind.

2

Black-and-white films and how to choose them

To help you choose the right films for your purposes, we've listed a number of popular black-and-white films for still photography in three major groups as follows:

1. *Films for most sharpness.* These are slow to medium-speed films with ultra-fine grain.
2. *Films for most versatility.* These are medium-speed films with medium-fine grain.
3. *Films for most speed.* These are divided into two groups: standard fast films with medium-coarse grain and super-fast films with very coarse grain.

[Polaroid films are listed separately at the end of this section.]

Of necessity, this grouping is arbitrary. In some cases, a film might with justification be listed in more than one category. For example, some of the high-speed sheet films are very versatile, some of the faster "most sharpness" films can be used for just about any kind of shooting except photography by very dim available light, and some of the "most versatile" films can rival many "most sharpness" films in fine grain and sharp detail. So consider the following charts as guides only. *Your ultimate choice of films for different purposes should depend on your own needs and working methods.*

Only a single exposure index is shown in the charts. In the past, a separate set of ratings was given for "tungsten" illumination–artificial light from studio floods, etc. This is no longer considered necessary with most panchromatic films because of improved film emulsions and exposure meters.

All the films listed have panchromatic emulsions unless specifically designated as being orthochromatic films. With ortho films it may be desirable to reduce the exposure index up to one half when using photofloods or studio lights, because ortho films, unlike modern pan films, are relatively insensitive to artificial illumination.

The exposure indexes given in the charts are the official ASA speed ratings of the film manufacturer. However, remember that these exposure indexes

apply *only when you develop the film according to the manufacturer's instructions, and in a developer recommended by him* [*or one with similar characteristics*].

Naturally, if a film manufacturer also makes developers, he'll usually recommend a developer of his own make. However, there are a number of excellent developers on the market. If you use a developer other than the one recommended by the film maker, use the exposure index given by the *developer* manufacturer if this differs from the official ASA rating.

1 Films for most sharpness

These are ultra-fine-grain films of slow to medium speed. They are sometimes called "thin-emulsion" films because they are coated with a very thin layer of emulsion which increases the sharpness with which they can record an image.

You might choose a film from this group when you want a crisp, extra-sharp image of a subject containing fine detail–especially if you are shooting with 35-mm or roll film and plan to enlarge the negative considerably. Many landscape, architectural, industrial, portrait, still-life, and fashion subjects might best be handled with one of these films. They are designed for use in fairly bright light–daylight outdoors, or flash or flood inside.

Ultra-fine-grain films of slow to medium speed

Manufacturer and film name	ASA exposure index	Available in		
		35 mm	roll film	sheet film
Adox KB14	20	X		
R14	20		X	
KB17	40	X		
R17	40		X	
Agfa Isopan IFF	25	X	X	X
Ilford Pan F	50	X		
Kodak Panatomic-X	40	X	X	X*

*Sheet film Panatomic-X is rated at ASA 64.

2 Films for most versatility

The films in this group have medium speed and medium-fine grain–a combination that makes them suitable for a great range of photography. Standardize on one of these films, learn its characteristics thoroughly, and you'll be able to handle almost any lighting condition indoors or out, except extremely poor available light. Most of your School Assignments can be done with one of these films.

Medium-speed films with medium-fine grain

Manufacturer and film name	ASA exposure index	Available in		
		35 mm	roll film	sheet film
Adox				
KB21	100	X		
R21	100		X	
Agfa				
Agfapan	200		X	
Isopan IF	100	X	X	
Isopan ISS	200	X	X	
Ansco				
All-Weather Pan	125		X	
Superpan Portrait	100			X
Versapan	125	X	X	X*
Vivipan	125			X

*Sheet film Versapan is rated at ASA 100.

Medium-speed films [*continued*]

Manufacturer and film name	ASA exposure index	Available in		
		35 mm	roll film	sheet film
Du Pont				
Cronar X-F Pan	125			X
Ilford				
FP3	125	X	X	X
Kodak				
Plus-X Pan	125	X	X**	X
Portrait Panchromatic	125			X
Super Speed Ortho Portrait***	125			X
Verichrome Pan	125		X	
Perutz				
Perutz 21	100		X	

**Roll film is designated Plus-X Pan Professional and is available only in packages of 25 rolls–120 or 620 size.
***Orthochromatic.

3 Films for most speed

There are two groups in this category, standard fast and super-fast films. The first chart lists *standard fast films* with medium-coarse grain. These often are a good choice for available-light shooting where a medium-speed film requires you to use too slow a shutter speed or too wide an aperture. The sheet films in the standard fast group are widely used for general shooting in press, portrait, and commercial photography because the extra speed is convenient, while the grain is not objectionable in a large negative that needs relatively little enlargement. But for best quality with roll-film or 35-mm cameras, you'll probably do better to use a medium-speed or slow-speed film when the lighting permits.

Standard fast films with medium-coarse grain

Manufacturer and film name	ASA exposure index	Available in		
		35 mm	roll film	sheet film
Agfa				
Isopan Ultra	400	X	X	X
Ansco				
Super Hy-Ortho*	250			X
Super Hypan	500	X	X	X
Superpan Press	200			X
Triple S Pan	400			X
Du Pont				
Cronar Arrow Pan	320			X
Cronar High Speed Pan	320			X
Cronar Press	400			X
Ilford				
HP3	400	X	X	X
Hyperchromatic*	400			X
Kodak				
Royal Ortho*	400			X
Royal Pan	400			X
RS Pan	650			X
Super Panchro-Press, Type B	250			X
Super-XX Panchromatic	200			X
Tri-X Pan	400	X	X	X**
Tri-X Pan Professional	320		X***	

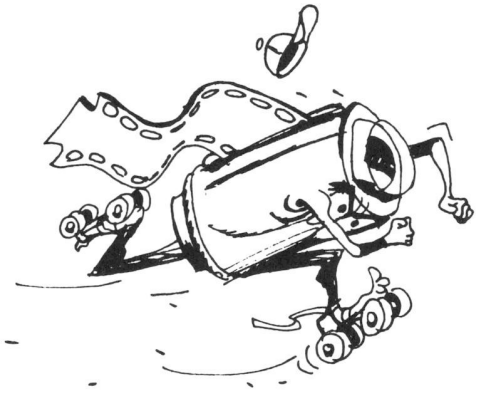
*Orthochromatic.
**Sheet film size Tri-X Pan is rated at ASA 320.
***Available in 20-roll packs, 120 and 220 only.

Super-fast films with coarse grain

In this chart we list the *super-fast films* with very coarse grain which should be used only when the light is so bad that you must have the extra speed or lose your picture. When covering a sports event by available light, for example, you might require a fast shutter speed to stop action. A film from this category might provide the solution.

Manufacturer and film name	ASA exposure index	Available in		
		35 mm	roll film	sheet film
Agfa				
Isopan Record	1250	X	X	X
Ilford				
HPS	800	X	X	X
Kodak				
Royal-X Pan	1250	X*	X	X

*Available in bulk loads only under the designation of Royal-X Pan Recording.



Polaroid films

Polaroid films are designed to be developed *in the camera.* For development-time requirements refer to the film data sheet. All Polaroid films listed produce black-and-white positive prints except as otherwise indicated.

Film name	ASA exposure index	Available in
Type 32	400	small roll-film size– 8 prints [2 1/4 x 3 1/4] per roll
Type 37	3000	

Polaroid films [*continued*]

Film name	ASA exposure index	Available in
Type 42	200	large roll-film size– 8 prints [3 1/4 x 4 1/4] per roll
Type 44	400	
Type 47	3000	
Type 107	3000	8 prints in a pack for Automatic Land cameras
Type 52	200	4 x 5 sheet film in boxes of 12 sheets
Type 55 P/N*	100	
Type 57	3200	

* Produces both a print and a negative

Polaroid projection [black-and-white transparency] films

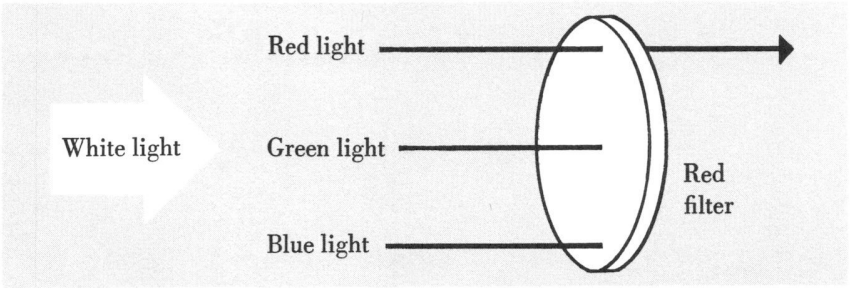
Film name	ASA exposure index	Size and purpose
Type 46	800	8 exposures per roll, makes 2 1/4 x 2 1/4 continuous-tone slides
Type 46-L	800	8 exposures per roll, makes 3 1/4 x 4 continuous-tone slides
Type 146-L [PolaLine]	200	8 exposures per roll, makes 3 1/4 x 4 slides, a high-contrast film for line copy only

3

Filters for black-and-white photography

The purpose of this section is to help you select the right filters for your black-and-white shooting. We discussed some important filters and demonstrated their effects in the lesson on black-and-white photography. Here we'll go into the subject in more detail and list filters for general shooting as well as filters that can help you solve special problems.

First, let's briefly review how filters work. What we see as "white" light is considered to be a mixture of red, green, and blue light—the three *primary* colors of light. [See the discussion of light and color in the section on color films.] Any colored filter you place on your lens does two things: [1] It passes light of its own color, and [2] it blocks light of other colors. Another way of saying this, common in photographic discussions, is that the filter *transmits* light of its own color and *absorbs* light of other colors. The accompanying diagram of a red filter will help explain this action.



A red filter transmits or passes red light and absorbs or blocks blue and green. In a black-and-white picture taken with this filter, anything which is red will be *lightened* in tonal value while green and blue will be darkened.

Remember this rule whenever you are in doubt about a filter and its effect:

A filter transmits light of its own color, and this color is lightened in the picture; it absorbs other colors, which are darkened in the picture.

The following chart indicates the effect of different colored filters on red, green, and blue. Notice that a yellow filter transmits and lightens both red and green light. The reason for this is that yellow light is actually a mixture of red and green light.

What filters do

Filter	Three primary colors of light		
	red	green	blue
yellow	transmits and lightens	transmits and lightens	absorbs and darkens
green	absorbs and darkens	transmits and lightens	absorbs and darkens
orange	transmits and lightens	absorbs and darkens	absorbs and darkens
red	transmits and lightens	absorbs and darkens	absorbs and darkens
blue	absorbs and darkens	absorbs and darkens	transmits and lightens

Use the next chart as a guide if you want to lighten or darken a particular color in a picture when using *panchromatic* films. For example, to make a light pink object stand out more strongly from a light green background you might use a green filter because it will darken the pink and make the green background lighter.

Filters to lighten or darken colors [*with panchromatic film only*]

Color of subject	Filter that will lighten this color	Filter that will darken this color
blue	blue	red, yellow, or orange
blue-green	blue or green	red, yellow, or orange
green	yellow, green, or orange	red or blue
yellow	yellow, green, orange, or red	blue

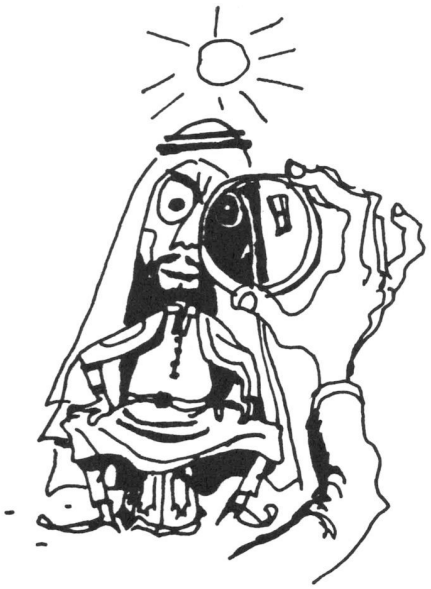
Filters to lighten or darken colors [*continued*]

Color of subject	Filter that will lighten this color	Filter that will darken this color
orange	yellow, orange, or red	green or blue
red	red	blue or green
purple	blue	green
pink	red	green
brown	orange or red	blue

Corrective and contrast filters

Filters for black-and-white photography can be classified into two main groups –*corrective* and *contrast.*

Corrective filters are ones you would use to record the various colors of the subject as natural-looking shades of black, white, and gray. Although most modern films are panchromatic–that is, sensitive to light of all colors–they do not "see" colors in exactly the same way the human eye does. In general, they are more sensitive to *blue* light than the human eye is. They tend to record blue [and colors containing blue] too light. On the other hand, colors containing red or green tend to come out too dark. This effect may be very slight–so slight that you may not require a filter to correct it. However, for photographing the following subjects on panchromatic film, use the filters recommended in order to obtain the most natural rendition of values.



Outdoor scenes: Use a medium yellow filter. This filter absorbs some of the blue light to which black-and-white panchromatic film is especially sensitive, and it darkens any blues [or colors containing blue] so they appear more natural in relation to other colors. An important use of this filter, demonstrated in your text, is to darken blue sky so that white clouds stand out more strongly.

Outdoor portraits: A medium yellow filter may record lips a little too light and flesh tones too pale. Therefore, for close-ups of people outdoors, some photographers prefer to use a light green filter instead. The light green filter records reds and flesh tones a little darker than does the medium yellow. It also slightly darkens blue sky and lightens green foliage.

Contrast filters

Contrast filters are stronger and darker in color and more powerful in their effect than are corrective filters. They are used in black-and-white photography to *exaggerate* the difference between colors. For example, you might use a contrast filter when copying a blueprint to make the blue come out very dark

in relation to the white lines, or to make blue sky dramatically dark in a scenic or architectural photograph.

The most generally useful contrast filters are the dark yellow, orange, and red. Their applications to creative photography are discussed and demonstrated in your text. Less frequently useful are the dark red, dark green, and blue filters.

Filters and orthochromatic film

With orthochromatic film, generally available only as sheet film, you can use a medium yellow filter if you want to lighten green and darken blue. This may be helpful in scenic photography with ortho film. The results are similar to what you would get with a medium yellow filter and panchromatic film except that *red and orange will be recorded very dark.* [Ortho film is relatively insensitive to red light.] A dark yellow filter also can be used with ortho film, making blue sky go very dark, and a medium green filter can be used to lighten green foliage.

However, a red filter should not be used with ortho film. It will result in no image at all unless you resort to impractically long exposures.

Polarizing filters

These filters are useful both in black-and-white and color photography. For their application to color shooting, see the section on filters for color photography later in this manual.

Polarizing filters are gray. Because of this they do not alter the color of the light passing through them. However, they have two useful effects: [1] they darken blue sky *without affecting any other colors in the scene,* and [2] they reduce or, in some cases, entirely remove reflections from the surface of nonmetallic materials such as glass, water, polished wood, plastic, linoleum, etc.

You can see a polarizing filter's effect if you hold the filter in a vertical position and slowly rotate it either clockwise or counterclockwise. As you rotate it, you will observe blue sky gradually become darker, then lighter again.

Types of polarizing filters

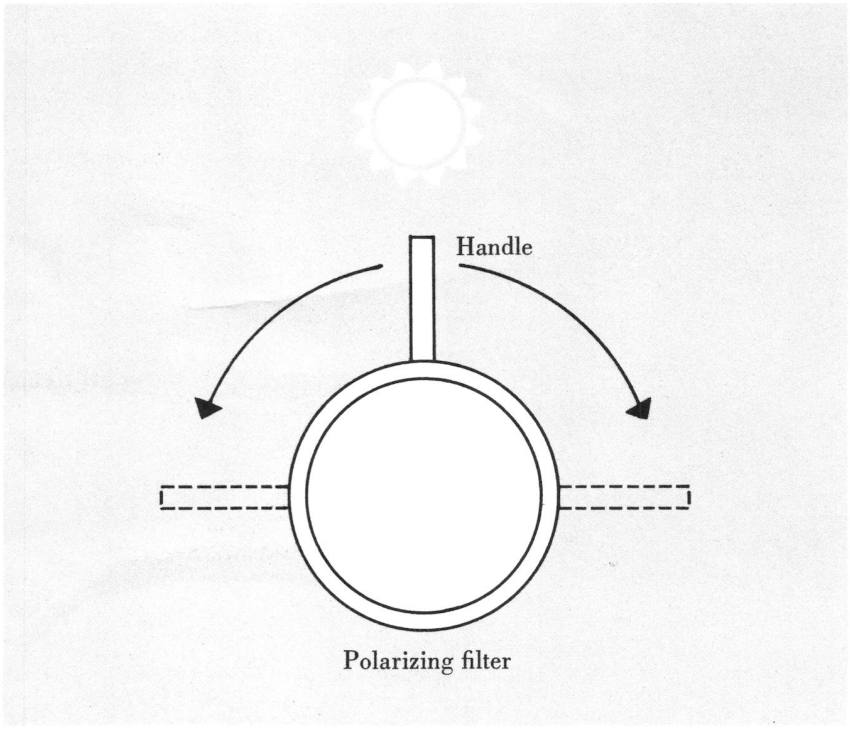
Polarizing filters are available in two basic types: [1] as disks, similar to ordinary filters, and [2] with an indicator handle attached to the rim.

The disk type is adequate when used on a single-lens reflex, view camera, or press camera with a groundglass back. As you rotate the filter, you can observe its effect directly on the groundglass.

With a twin-lens reflex, place a disktype polarizing filter on the top [viewing] lens and rotate the filter until you get the desired effect. Then transfer it to the bottom [taking] lens before you shoot the picture. Of course, be sure the filter is exactly at the same angle when you place it on the taking lens as it was on the viewing lens.

If you use a simple disktype polarizing filter with a rangefinder or other camera lacking a groundglass, follow this procedure. Hold the filter in approximately the same position as you plan to hold the camera and look through it at the scene. Rotate the filter until you see the effect you want—darkened sky or reduced reflections. Then place the filter on the camera lens, keeping the filter at the same angle. [Some polarizing filters have degrees engraved on them to help you maintain any desired angle.]

A polarizing filter equipped with an indicator handle can be controlled without your needing to look through it. If you want to darken blue sky, you'll get the greatest effect with the handle pointing directly at the sun. If you rotate the filter so that the handle turns away from the sun, you will progressively decrease the filter's effect until the handle has turned through an arc of 90 degrees.



Turning the handle of a polarizing filter away from the sun [in the direction of either of the two arrows shown in the accompanying diagram] decreases its sky-darkening effect. When the handle is pointed toward the sun, the filter will have its greatest sky-darkening effect.

In controlling reflections on horizontal surfaces, such as on a pool of water, you'll get the greatest effect if the handle is in a *vertical* position. For reflections on a vertical surface, such as a store window, you'll get the greatest effect when the handle is turned *parallel to the horizon line* and the subject is at about a 35-degree angle to the lens.

Ways to use a polarizing filter

With either type of polarizing filter, you get the greatest sky-darkening effect in the area which is at 90 degrees or at right angles to the sun. Little or no effect will take place if the lens is facing directly toward or away from the sun. Also, a polarizing filter has little or no effect on hazy or cloudy sky.

If you combine a polarizing filter with a medium yellow filter when using black-and-white film, you can produce very dark sky tones while achieving a normal rendition of foreground objects at the same time.

Some manufacturers supply small auxiliary polarizing filters for viewing. These fit on the end of the indicator handle. With one of these in place you can leave the main filter on the camera, rotate the handle, and view the effect you're getting through the auxiliary filter.

Use a filter factor of 3 as the basis for your own tests with a polarizing filter. Or, if you want to eliminate the need for using a filter factor, take your exposure meter reading *through* the filter, holding it at the angle and position you plan to use when you take your picture.

Neutral density filters

Neutral density or ND filters, as they sometimes are called, are gray filters used *to reduce the amount of light* passing through the camera lens *without* changing the rendition of colors in black and white. In other words, they cut down the exposure without affecting the way colors look in your photographs.

Uses of ND filters

There are a number of picture-taking situations where a neutral density filter can be helpful. For example, suppose your camera is loaded with a very fast film for indoor shooting and you decide to go outside and take photographs by bright sunlight. Even the fastest shutter speed on your camera and its smallest aperture still might give you an overexposed picture. Putting a neutral density filter on the camera can reduce the light reaching the film so that you get correct exposure.

Another situation where a neutral density filter can help is when you want to open up to a wider aperture to throw the background out of focus without changing shutter speed. On the other hand, you might want to use a slow shutter speed for blurred-action effects but already are stopped down as far as your lens will go. An ND filter can permit you to do these things without overexposing the picture.

Neutral density filters are supplied in various strengths or densities. The following chart shows the percentage of light transmitted by various strengths of ND filters and the corresponding filter factor. Particularly useful are the 0.30 [also designated as 2X by some manufacturers], the 0.60 [4X], and the 0.90 [8X]. The 0.30 cuts down exposure the equivalent of a full stop, the 0.60 equals two stops, and the 0.90 equals three stops.

Densities, light transmission, and filter factors of neutral density filters

Density	Percent of light transmitted	Filter factor
dummy*	100.0	1.0
0.10	80.0	1.2
0.20	65.0	1.5
0.30 [2X]	50.0	2.0
0.40	40.0	2.5
0.50	32.0	3.1
0.60 [4X]	25.0	4.0
0.70	20.0	5.0
0.80	16.0	6.2
0.90 [8X]	13.0	7.7
1.00	10.0	10.0
1.20	6.3	15.8
1.30	5.0	20.0
1.50	3.2	31.2
2.00	1.0	100.0
2.50	0.32	312.0
3.00	0.10	1,000.0
3.50	0.032	3,125.0
4.00	0.001	10,000.00

*A colorless filter supplied by Kodak for focusing when Kodak neutral density filters are to be used.

The three charts which follow show the correct neutral density filter or combination of ND filters to use if setting your camera at its smallest stop still gives you too much exposure. For example, assume that you want to use a shutter speed of 1/10 second to get motion blur. Your meter indicates that your exposure should be 1/10 second at *f*/45, but your lens only stops down to *f*/22. Look at Chart B and you'll see that adding an 0.60 neutral density filter will give you correct exposure with your camera set at 1/10 second and *f*/22.

Which neutral density filters to use when your lens doesn't stop down far enough for correct exposure

Chart A

If your smallest *f* stop is *f*/16 and this *f* stop is required for correct exposure . . .	use this ND filter [or combination]
f/22	0.30
f/32	0.60
f/45	0.90
f/64	0.90 plus 0.30
f/90	0.90 plus 0.60
f/128	0.90 plus 0.90
f/180	2.00 plus 0.10
f/256	2.00 plus 0.40

Chart B

If your smallest *f* stop is *f*/22 and this *f* stop is required for correct exposure . . .	use this ND filter [or combination]
f/32	0.30
f/45	0.60

Chart B [*continued*]

If your smallest *f* stop is *f*/22 and this *f* stop is required for correct exposure . . .	use this ND filter [or combination]
f/64	0.90
f/90	0.90 plus 0.30
f/128	0.90 plus 0.60
f/180	0.90 plus 0.90
f/256	2.00 plus 0.10

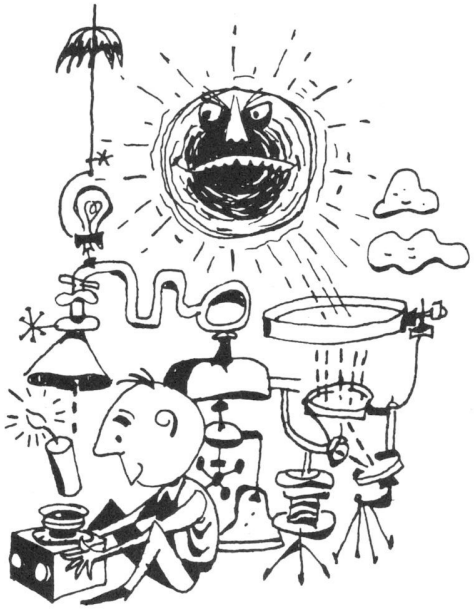
Chart C

If your smallest *f* stop is *f*/32 and this *f* stop is required for correct exposure . . .	use this ND filter [or combination]
f/45	0.30
f/64	0.60
f/90	0.90
f/128	0.90 plus 0.30
f/180	0.90 plus 0.60
f/256	0.90 plus 0.90

The next chart shows you what neutral density filter or filters to use if you want to open up your lens to a wider aperture *without changing shutter speed or increasing exposure.* For example, suppose you are shooting outdoors in bright light. Your exposure is 1/250 second [the fastest shutter speed on your camera] at *f*/8. You want to use an aperture of *f*/4 to give you shallow depth of field to blur background details. Look at the chart and you'll see that if you add an 0.60 ND filter you can open up to *f*/4 without increasing your exposure.

Which neutral density filters to use when you want a wider aperture without increasing exposure

Aperture required for correct exposure without ND filter	If your desired aperture is . . .				
	f/5.6	*f*/4	*f*/2.8	*f*/2	*f*/1.4
	use this ND filter [or combination]				
f/8	0.30	0.60	0.90	0.90 plus 0.30	0.90 plus 0.60
f/11	0.60	0.90	0.90 plus 0.30	0.90 plus 0.60	0.90 plus 0.90
f/16	0.90	0.90 plus 0.30	0.90 plus 0.60	0.90 plus 0.90	2.00 plus 0.10
f/22	0.90 plus 0.30	0.90 plus 0.60	0.90 plus 0.90	2.00 plus 0.10	
f/32	0.90 plus 0.60	0.90 plus 0.90	2.00 plus 0.10		



Filter factors

Most filters hold back an appreciable amount of light and therefore you need to increase exposure when you use them. The amount of exposure increase necessary is expressed as a *filter factor*. The following chart shows the average filter factors for most panchromatic and orthochromatic films when used in daylight and by incandescent light. The factors shown in this table are correct for most normal conditions. However, specific makes of film may vary in their performance, and the color quality of your light source also can influence the filter factor you should use.

For example, in the chart you can see that a medium yellow filter [K2] used in daylight has a factor of 2–sometimes written as 2X–meaning an exposure increase of 2 times is required. [Remember, the purpose of this filter is to hold back some of the *blue* light.] If you look at the chart again you'll see that the filter factor for the same filter used by incandescent light is only 1.5X. The

reason is that incandescent light [from photofloods, studio floodlights, or electric light bulbs, etc.] is more yellowish than is ordinary daylight. It has less blue for the filter to absorb. In a similar manner, if you use a K2 filter by the yellowish light of late afternoon, a filter factor of less than 2 may give the best results.

On the other hand, if a medium yellow filter is used on a cloudy day, when the light is more bluish than it is on a bright day, the filter factor may need to be increased a little.

Because of these possible variations in effect, it is a good idea for you to run tests with your particular film, filters, and equipment. Use the filter factors in this chart as guides, bracket your exposures, keep a record of the exposures, and analyze the results you get. Then make a record of your own personal filter factors that give you the results you want.

Filter factors for pan and ortho films

Filter	Wratten designation*	Factor			
		panchromatic films		orthochromatic films	
		daylight	incandescent light	daylight	incandescent light
light yellow	K1	1.5X	1.5X	2X	1.5X
medium yellow	K2	2X	1.5X	2.5X	2X
light green	X1	4X	3X	6X	5X
dark green	X2	5X	4X	8X	6X
dark yellow or orange	G	3X	2X	5X	3X
red	A	8X	4X	**	**
dark red	F	16X	8X	**	**
blue	C5	5X	10X	3X	4X
polarizing		3X***	3X***	3X***	3X***

*A system of identifying filters used by Kodak and some other manufacturers.
**Not recommended.
***This is an average factor. It may vary somewhat depending on the angle and position of the filter.

How to use filter factors

Three methods are in general use for employing filter factors. They are:

1. *Divide the exposure index of the film you're using by the filter factor.* This is a convenient method when using an exposure meter, and can be applied to color as well as black-and-white film. For example, let's assume you are using Panatomic-X film at an exposure index of 40 without a filter. You want to use a medium yellow filter with a factor of 2X for daylight. Divide the factor [2] into your exposure index [40] and you get 20. Set your meter for an exposure index of 20 and use as you normally would. Naturally, if you take the filter off the lens you should reset your meter dial to an index of 40 again.

2. *Divide your shutter speed by the filter factor.* This method is helpful whenever you want to maintain a particular *f* stop.

Let's assume you're shooting pictures with the shutter set at 1/60 second and you are going to use a light green filter having a factor of 4X for daylight. Take the lower part of the fraction–60–divide by the factor 4 and you get 15. Use this as the lower part of a new fraction–1/15–to get the new shutter speed.

3. *Use a larger lens opening.* This method is generally employed when you need to maintain a given shutter speed in order to stop action. Remember, each time you open up the lens a full stop, you double the exposure. For example, going from *f*/5.6 to *f*/4 doubles the exposure. Going from *f*/4 to *f*/2.8 doubles it again. Therefore, if you open up two stops– *f*/5.6 to *f*/2.8–you give *four* times as much exposure.

The following filter factor conversion chart can save you the bother of calculating which *f* stop you need for a given filter factor.

Filter factor conversion chart

Filter factor	If normal *f* stop without filter is . . .										
	2.0	2.5	2.8	3.5	4.5	5.6	6.3	8	11	16	22
	f stop with filter is										
1.5	1.6	2.0	2.3	2.9	3.7	4.6	5.1	6.6	9.2	13.0	18.5
2	1.4	1.8	2.0	2.5	3.2	4.0	4.5	5.6	8.0	11.0	16.0
2.5	–	1.6	1.8	2.2	2.8	3.6	4.0	5.2	7.1	10.1	14.3
3	–	1.4	1.6	2.0	2.6	3.3	3.6	4.6	6.6	9.2	13.1
4	–	1.2	1.4	1.7	2.2	2.8	3.2	4.0	5.6	8.0	11.3
5	–	–	–	1.6	2.0	2.5	2.9	3.6	5.0	7.0	10.1
6	–	–	–	1.4	1.8	2.3	2.6	3.3	4.5	6.6	9.2
7	–	–	–	1.3	1.7	2.1	2.4	3.0	4.2	6.1	8.5
8	–	–	–	–	1.6	2.0	2.2	2.8	4.0	5.6	8.0
10	–	–	–	–	1.4	1.8	2.0	2.5	3.5	5.0	7.1

Filter construction

Filters for use on a camera lens are available commercially in three general forms. These are:

1. Thin sheets of dyed gelatin.
2. Gelatin or plastic material cemented between two pieces of optical glass. These are often called *laminated* filters. They are available as disks, either mounted or unmounted.
3. Dyed optical glass, also available as mounted or unmounted disks.

Gelatin filters

These are the least expensive type of photographic filters. They are mostly used for experimental work, especially in color, where many filters may be required. They also are used on large lenses, where a glass or laminated filter would be very expensive, and with certain lenses that have special built-in slots to hold gelatin filters.

Gelatin filters must be handled with care, preferably by the edges. Don't handle them any more than necessary since they scratch easily. Kodak gelatin filters are coated with a protective lacquer and may be cleaned by *gently* rubbing them with a clean *damp* but *not wet* cloth. However, do not expose them to heavy moisture or strong heat, or let drops of water fall on them.

For occasional use, gelatin filters may be taped to the lens. If you plan to use them a lot, a special holder for gelatin filters is recommended.

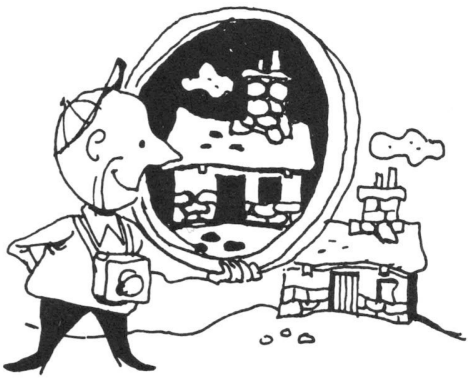
Laminated filters

This type of filter is more durable and more expensive than the gelatin type. However, be careful not to drop a laminated filter or expose it to excessive moisture or heat.

Certain dyes tend to fade more easily than others. For data on the dye stability of the filter you're using, consult the filter manufacturer. Generally, you need to be concerned about this only if you use filters frequently in bright light, or in very hot, humid climates.

Dyed optical glass

The dyes in these filters are the most stable, that is, they fade the least. Optical-glass filters are also the most durable. They cannot separate when dropped, nor will heat or moisture usually have any effect on them. However, optical-glass filters are not available in as great a number of hues or types as gelatin or laminated filters. Also, some optical-glass filters are relatively expensive.



Fitting filters to your lens

In general, there are three ways of holding a filter in front of your lens, depending on the type of filter.

1. By using a mount for gelatin filters.
2. By using mounted laminated or optical-glass filters that attach directly to your lens mount.
3. By using the *series system* of adapter rings for unmounted glass or laminated filters and for lens accessories, such as lens shades and close-up lenses.

Mounts for gelatin filters

The mounts to hold gelatin filters are simply slotted boxes. You attach the mount to your camera lens and then slide in a sheet of gelatin cut to the proper size. Gelatin-filter mounts are made in sizes to fit many cameras and lenses.

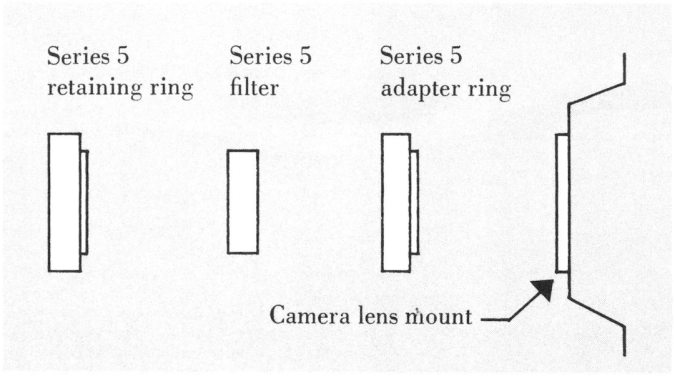
Mounted laminated or optical-glass filters

Laminated and optical-glass filters are available in mounts that attach directly to your lens. Some are designed to screw into threads on the front of the lens mount, some are "bayonet" mounts [you push and turn to attach], and others are "slip-on" mounts designed for use with simple cameras.

The big advantage of mounted filters is the speed and ease with which they can be attached. However, you'll need a different filter for each size of lens you have. This can be expensive and inconvenient, especially in color photography, where you may need a number of different filters.

The series system

A more versatile method of attaching filters is provided by the series system. The heart of this system is an *adapter ring*. The adapter ring is attached to your lens, and then an *unmounted* disk-shaped filter is placed in the adapter ring. The filter, in turn, is held in place by a *retaining ring* or a lens shade that screws into the adapter ring. [See the accompanying diagram.] Thus you can buy a number of unmounted filters to be used interchangeably in the same adapter ring. Series filters are supplied by some manufacturers in metal rims to prevent chipping.

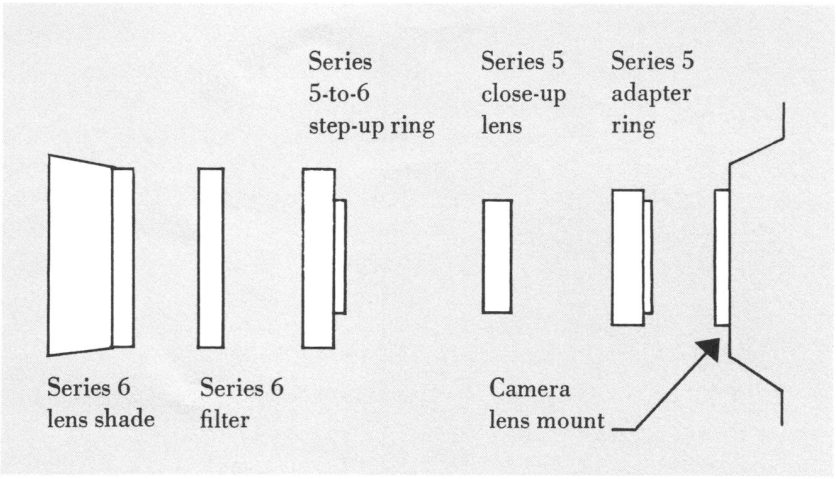


This diagram shows how a series filter is attached to a camera lens. In this example, a Series 5 adapter ring is attached to the lens mount. Then any Series 5 filter or other lens accessory can be placed in the ring and held in place with a Series 5 retaining ring.

Adapter rings are available in screw-in, bayonet, and "push-in" types–the latter being held in place by means of metal fingers that grip the inside of the lens mount. Still others are held in place by a setscrew. The type and size adapter ring you should get depends on the kind of camera you have and the size of its lens. Your camera instruction manual, camera dealer, or the filter manufacturer can give you guidance in choosing the best type for your equipment.

The term "series" refers to the *size of the disk accommodated by the front ["female"] end of the adapter ring.* The most commonly used series are 4, 5, 6, 7, 8, and 9, ranging in diameter from 1 3/16 inches to 3 1/4 inches. For example, a Series 5 adapter ring takes any Series 5 filter or accessory, such as a lens shade. For each series you can get an adapter ring of the correct size to fit a number of different cameras and lenses. This can be very economical since it allows you to use one set of filters with various lenses.

It's a good idea to buy filters of the *largest* size you intend to use. Then, if necessary, these can be used with smaller series size adapter rings by means of *step-up rings.* For example, a Series 5-to-6 step-up ring permits you to use Series 6 filters on a Series 5 adapter ring; a Series 6-to-7 step-up ring lets you use a Series 7 filter with a Series 6 ring, etc. You also can use step-up rings in combination. For example, a Series 5-to-6 plus a 6-to-7 step-up ring will let you use a Series 7 filter with a Series 5 adapter ring. [See the accompanying diagram.]



"Series" filters and other lens attachments can be used in many combinations. This diagram shows one arrangement: a Series 6 lens shade and filter, a Series 5-to-6 step-up ring, and a Series 5 close-up lens and adapter ring.

Although retaining rings are supplied with adapter rings, usually it's a good idea to hold the filter in place with a lens shade. The adapter ring provides a convenient way for attaching the shade, and the use of a lens shade is recommended for most of the shooting you do indoors or out.

The series system makes it possible for you to combine different filters and/or types of lens accessories. For instance, by using more than one retaining ring, you could combine a close-up lens and a filter or two or more filters. However, unless such a multiple combination is really a must, it's better from an optical standpoint to limit yourself to just one filter. The more filters you add, the greater likelihood there is of losing sharpness in your picture.

Before investing in adapter rings, filters, lens shades, and other accessories, we recommend that you check things out with your camera dealer. He can help you make a wise choice that will enable you to fill possible future needs as well as current ones most economically.

Equivalent filters

Methods of designating filters vary considerably from manufacturer to manufacturer. Throughout your Course we have identified filters by their color—light green, dark yellow, etc. This chart gives you the names of filters for black-and-white photography as they are designated by leading filter manufacturers [including some brands that have been discontinued].

Color or type filter	Wratten designation	Equivalent terms of various manufacturers
light yellow	K1	Burleigh Brooks: *Light Yellow* Ednalite: *Y-1* Enteco: *K1* Harrison & Harrison: *YL-1* Kodak: *K1* Leitz: *Yellow 0* Spiralite: *Light Yellow* Tiffen: *Yellow 1* Walz: *Y-1*
medium yellow	K2	Accura: *K2* Burleigh Brooks: *Medium Yellow* Ednalite: *Y-2* Enteco: *K2* Harrison & Harrison: *YL-3* Kodak: *K2* Leitz: *Yellow 1* Nikon: *Medium Yellow* Spiralite: *Medium Yellow* Tiffen: *Yellow 11* Walz: *Y-3*
dark yellow or orange	G	Accura: *G* Burleigh Brooks: *Orange* Ednalite: *O-2* Enteco: *G* Harrison & Harrison: *YL-6* Kodak: *G* Leitz: *Orange* Spiralite: *Orange* Tiffen: *Orange* Walz: *O-2*
light green	X1	Accura: *X1* Burleigh Brooks: *Light Green* Ednalite: *G-1* Enteco: *X1*

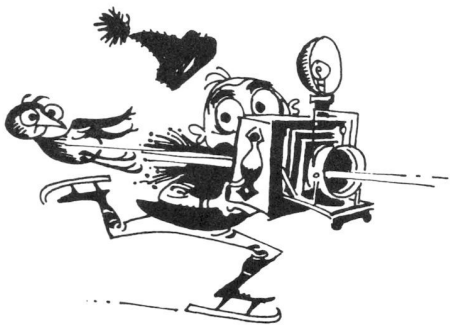
Color or type filter	Wratten designation	Equivalent terms of various manufacturers
light green	X1	Harrison & Harrison: *GR-4* Kodak: *X1* Leitz: *Green* Nikon: *Light Green* Spiralite: *Light Green* Tiffen: *Green 1* Walz: *G*
dark green	X2	Burleigh Brooks: *Green* Ednalite: *G-2* Enteco: *X2* Harrison & Harrison: *GR-5* Kodak: *X2*
red	A	Accura: *A25* Ednalite: *R-2* Enteco: *A25* Kodak: *A25* Leitz: *Red* Spiralite: *Red* Tiffen: *Red 1* Walz: *R-2*
dark red	F	Ednalite: *R-3* Enteco: *F* Harrison & Harrison: *RD-8* Kodak: *F* Leitz: *Medium* or *Dark Infrared*
blue	C5	Burleigh Brooks: *Light Blue* Ednalite: *Tricolor Blue* Enteco: *C5* Harrison & Harrison: *BL-10* Kodak: *C5* Leitz: *Blue*
polarizing		Accura: *Polarizing Filter* Burleigh Brooks: *Rolleipol* Ednalite: *Polarizing Filter* Enteco: *Polari View* Harrison & Harrison: *Polarizing Filter* HCE: *Rotopol* Kodak: *Pola-Screen* Spiralite: *Polarizing* Tiffen: *Polaroid Rotoscreen*

Which filter for which job?

Use this chart to select the right filter for different picture-taking purposes with black-and-white *panchromatic* film.

Subject	If you want this effect . . .	use this filter
clouds against clear blue sky or as a background	natural sky	medium yellow or light green
	darker-than-normal sky	dark yellow or orange
	very dark sky	red
	almost black	dark red
fabric—including draperies, upholstery, clothing, etc.	to darken	one of *complementary color* to the subject
	to lighten	one of the *same color* as the subject
flowers	lighten green foliage to make dark flowers stand out	light green
	lighten flowers to make them stand out against darker leaves	one as close as possible to the color of the flowers
glass objects, china, pottery, etc.	reduce unwanted reflections	polarizing
	darken to increase contrast and show up pattern, design details, etc.	one of *complementary color* to the subject
landscapes	natural	medium yellow or light green
	increased contrast and haze reduction	dark yellow or orange
	greater contrast and haze reduction	red

Subject	If you want this effect . . .	use this filter
marine scenes and subjects	natural rendition of water	medium yellow or light green
	darkened water	orange or dark yellow
outdoor portraits with sky showing	natural skin tones and natural sky	light green
polished surfaces– waxed floors, tiles, linoleum, formica, etc.	reduce reflections to show better detail	polarizing
portraiture	reduce contrast between blemishes and skin tones	medium yellow or dark yellow
	darken skin tones to emphasize tan or bring out rugged, masculine quality of male subject	light green
sand and snow, lighted by sun with blue sky	natural	medium yellow or light green
	increased contrast to emphasize texture	dark yellow, orange, or red
wood	emphasize grain of dark wood such as mahogany	red
	emphasize grain of yellowish woods such as maple, oak, walnut	dark yellow or orange
	emphasize grain of light, blond-finished woods	medium yellow



4

Using color films

To help you choose the best color films for your purposes throughout your Course, we've listed here popular makes of both transparency and color-negative films. In selecting a color film, choose one which is designed to give natural-looking color with the principal light source you plan to use–daylight, floods, flash, etc.

The human eye readily adapts itself to a variety of common sources of "white" light. [See the end of this section for a discussion of basic facts about light and color.] For example, a red rose surrounded by green leaves doesn't look very different if you examine it outdoors by sunlight and later take it indoors and look at it by the much warmer illumination from an electric light bulb. Part of this adaptation is physical, involving actual changes in the way the eye responds to light, and part is psychological–we tend to see things the way we like them or expect them to be.

Unlike human eyes, color films do not change their response to colors or variations in the warmth or coolness of light. To compensate for this, there are color films of different types, each one "balanced" so it will give its most realistic, natural-looking rendition of color when used with a particular light source.

If a color film is used with a light source other than the one for which it is balanced, the rendition of colors will not be correct. For example, as we demonstrate in the lesson on color photography, a daylight film used with 3200K studio floodlights will give pictures that are too warm–that is, too yellowish. On the other hand, if a film balanced for photofloods is exposed by ordinary daylight, the results will look too blue. So it's important to *use a film and light source that are balanced or matched.*

The coolness [bluishness] or warmth [yellowishness] of "white" light is called its *color temperature* and is measured by degrees Kelvin [K, for short]. The higher the color temperature, the relatively cooler the light. The following chart gives the color temperature of various sources of "white" light.

Color temperature [in degrees Kelvin] of commonly used photographic light sources

	Light source	Color temperature
Cooler	light reflected from blue sky*	10,000K to 20,000K
	overcast daylight*	7500K
	average daylight* [a mixture of sunlight and light reflected from blue sky]	6000K
	blue flashbulbs	6000K
	electronic flash**	5000K to 6000K
	noon sunlight*	5500K
	white flashbulbs	3800K
	photofloods	3400K
	3200K professional studio lights	3200K
	household electric light bulbs***	2800K
Warmer	candle flame or kerosene lamp	1900K

*Approximate–applies to the United States only.
**Approximate–may vary according to make of flash unit and condition of tube and batteries.
***Approximate–varies with wattage and age of bulb, and voltage of current.

Sometimes, of course, it may be impossible to use a film and light source that are correctly matched. You might have a partly exposed roll of color film in your camera and want to expose the remaining film by a light source for which it is not balanced. Sometimes, too, you may encounter a light source for which there is no matching color film. On these occasions filters can be used to adjust the quality of the light to match the film. Recommendations for the use of filters in color shooting are given in Section 5.

In the tables below we've listed popular color-transparency films in three categories, according to the light for which they are balanced:

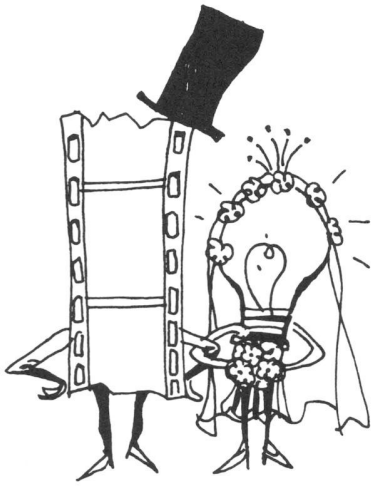
1. Daylight type–for daylight and for electronic flash or *blue* flashbulbs
2. Type A–for 3400K photofloods
3. Type B–for 3200K studio lights

Additional tables are given for color-negative films, which are supplied in two basic color balances:

1. Electronic flash, blue flashbulb, or daylight type
2. Type B–for 3200K studio lights

Exposure indexes are given for the color films when used with the light source for which they are balanced. For exposure indexes when color films are used with light sources other than those for which they are balanced, see the filter charts for color photography in the following section.

Color-transparency films



Daylight type transparency films

Manufacturer and film name	ASA exposure index	Available in		
		35 mm	roll film	sheet film
Agfa				
Agfachrome CT 18	50	X	X	
Agfachrome Professional CT	50-80		X	X
Ansco				
Anscochrome	32			X
Anscochrome D/50	50	X	X	
Anscochrome D/100	100	X		
Anscochrome D/200	200	X		
Dynacolor [3M]				
Dynachrome	25	X		
Kodak				
Ektachrome Professional	50		X	X
Ektachrome-X	64	X*	X**	
High Speed Ektachrome	160	X	X	
Kodachrome II	25	X*		
Kodachrome-X	64	X*	X**	
Perutz				
Peruchrome	32	X	X	

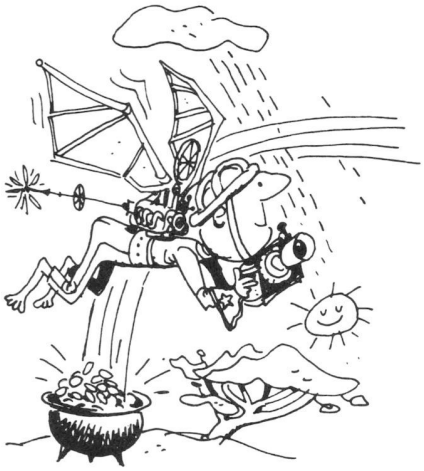
*Also available in 828 bantam rolls.
**Available in 126 Kodapaks.

Type A transparency film [balanced for 3400K photoflood bulbs]

Manufacturer and film name	ASA exposure index	Available in		
		35 mm	roll film	sheet film
Kodak				
Kodachrome II Professional Type A	40	X		

Type B transparency films [balanced for 3200K studio lights]

Manufacturer and film name	ASA exposure index	Available in		
		35 mm	roll film	sheet film
Agfa				
Agfachrome CK 20	80	X	X	
Agfachrome Professional CK	50-80		X	X
Ansco				
Anscochrome Tungsten	25			X
Anscochrome T/100	100	X		
Kodak				
Ektachrome Type B	32			X
High Speed Ektachrome Type B	125	X	X	



Color-negative films

Electronic flash, blue flashbulb, or daylight type

Manufacturer and film name	ASA exposure index	Available in		
		35 mm	roll film	sheet film
Agfa				
Agfacolor CN17	40	X	X	X
Kodak				
Ektacolor Professional [Type S]*	100		X	X
Kodacolor-X	80	X	X**	

*This film is designed for use at exposures of 1/10 second or shorter.
**Available in 126 Kodapaks and 828.

These films may be exposed by daylight, blue flashbulbs, or electronic flash without a filter, when printing is to be done by a photofinisher. If you do your own color printing, you may also use these films with white flashbulbs in order to maintain a particular printing-filter balance to which you may have become accustomed.

Type B color-negative film [for use with 3200K studio lights]

Manufacturer and film name	ASA exposure index	Available in		
		35 mm	roll film	sheet film
Kodak				
Ektacolor Type L*	64**			X

*This film is designed for use at exposures of 1/10 second or longer.
**The exposure index given here is for an exposure of 1/10 second.

The following indexes and filters apply to other exposure times:

Light source	Filter	Exposure time	Effective exposure index
3200K	none	1 second	80
3200K	none	5 seconds	64
3200K	none	60 seconds	32
photofloods	81A	1 second	64
daylight	85	1/10 second	64

Polacolor film

This is a special color film for use in Polaroid Land cameras and cameras that accept a 4x5 Polaroid Land film holder. It produces color prints in the camera with a development time of 50 seconds. This film is designed for exposure in daylight or with M3 white flashbulbs used in a special blue-shielded reflector available from Polaroid.

Film name	ASA exposure index*	Available in
Type 38	75	small roll-film size– 6 prints [2 1/4 x 3 1/4] per roll

*At temperatures above 60 degrees F.

Polacolor film [*continued*]

Film name	ASA exposure index*	Available in
Type 48	75	large roll-film size– 6 prints [3 1/4 x 4 1/4] per roll
Type 108	75	8 prints [3 1/4 x 4 1/4] in a pack for Automatic Land cameras
Type 58	75	4x5 sheet film

*At temperatures above 60 degrees F.

Some basic facts about light and color

In order for us to see anything or to photograph anything, there must be light. The rays of light that come to us from the sun we call white light. This white light actually contains all the colors that we see around us. If white light is passed through a prism, the prism breaks the white light into various parts. We see a continuous rainbow of colors.

The proportion of these colors can be varied somewhat and the resulting mixture will still look like "white" light when viewed under certain conditions. For instance, a household electric light bulb appears to give white light when viewed alone. However, it contains a relatively greater amount of yellow light than does daylight. If you turn the same bulb on in a room illuminated by daylight you can easily see that its light is more yellow by comparison.

White light can be created by mixing *red*, *blue*, and *green* light only. For example, if you took three projectors and projected a beam of red light from one, blue light from the second, and green from the third, you would get white light where all three beams overlapped. Therefore, red, blue, and green are called the three *primary colors* in photography. Practically all other colors can be created by mixing various portions of these three. The creating of different colors by mixing light is called the *additive* system of color.

If we mix blue and green light only, we get a greenish blue called *cyan*. If we mix red and blue we get a bluish red called *magenta*. If we mix red and green, we get *yellow*. Remember, we are dealing with *mixtures of light* here, not with mixtures of colored pigments.

These three mixed colors of light–yellow, magenta, and cyan–are called the *complements* of blue, green, and red respectively. If you take one of the primary colors and mix its complement with it, you get white light. White light can be made by mixing blue and yellow light, or magenta and green light, or cyan and red light. The chart at left expresses the relationships in simple form. This information has practical application in the processing of color film–especially in the selection of filters for color printing, which is covered in a later section.

Mixing colors of light

blue + green = cyan

green + red = yellow

red + blue = magenta

cyan + red
yellow + blue
magenta + green } = white

5

Filters for color photography

In color photography, filters are used for two main purposes: [1] to change the color of the light so that it matches the light for which the film is balanced, thus giving you a normal rendition of colors; [2] to change the color in the resulting picture to suit your personal taste or for a special effect. For this latter purpose, *any* filter can be used provided it alters the color the way you want it to.

Filters commonly used to get normal color rendition are the *haze*, *UV*, and *skylight* types, *conversion filters*, and *light-balancing filters*. [Similar in purpose to the conversion and light-balancing filters are Ednalite Color-Toning Filters, Harrison Light-Corrector Discs, and decamired filters.]

Color-compensating filters [often called CC filters for short] have many applications in color printing as well as in shooting.

Polarizing filters and neutral density filters, described in detail in the section on filters for black-and-white photography, also are useful in color work. We'll discuss each of these types and their uses in this section.

Since a filter absorbs some of the light, an increase in exposure often is required when you use one. In color photography the increase usually is given in tables of film-filter combinations as an adjusted exposure index to be used when that filter is employed.

Skylight, UV, and haze filters

Pictures taken outdoors in daylight may sometimes have an unwanted bluish cast if shot without a filter on daylight type color-transparency film.

One reason for this is the presence of ultraviolet rays [called UV for short] in daylight. Although the human eye cannot see these ultraviolet rays, color film "sees" them and records them as visible blue in the final picture.

This is most likely to happen when taking pictures near large bodies of water or at high altitudes, in aerial photography, and in pictures of distant landscapes. With distant landscapes, water vapor or haze in the air scatters the ultraviolet rays, which are rendered as a blue haze that obscures far-off details.

Skylight, UV, and haze filters prevent excess bluishness by blocking or absorbing some ultraviolet radiation so that it will not be recorded on your film.

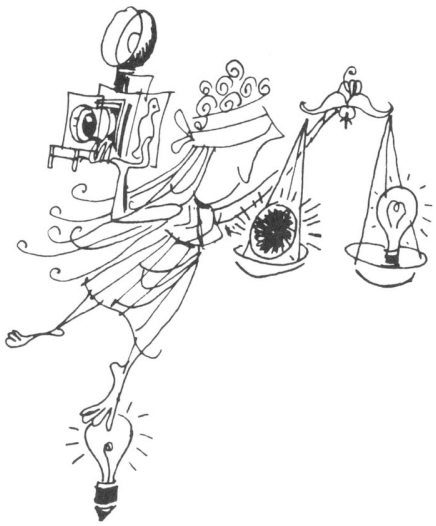
Another use for these filters is to prevent scenes photographed on cloudy days or in the open shade from coming out too bluish. Under these conditions the light is usually bluer than the mixture of sunlight and skylight for which daylight color films are balanced. Skylight, UV, and haze filters used in these situations will add extra warmth or yellowishness to the rendition of the scene.

The effects obtained from skylight, UV, and haze filters are not identical. Skylight [sometimes designated as 1A] filters have a slightly pinkish tint and are recommended for use with Kodak films. They may also be used with some success on Ansco materials. UV filters have a yellowish tint and work best with Adox, Agfa, Ansco, Perutz, and most foreign color films. When UV filters are used with Kodak films the result is apt to be a bit too yellowish for most tastes.

Haze filters are practically colorless. They usually have less ultraviolet stopping power than skylight or UV filters. Their chief use is to absorb some of the ultraviolet rays without making much of a color change.

Because little or no color change is caused by skylight, UV, and haze filters when shooting in sunlight, many photographers leave them on the lens at all times as insurance against the adverse effects of ultraviolet rays.

No increase in exposure is required with any of these filters.



Conversion and light-balancing filters

It is not always possible to have the right kind of film in the camera for the illumination falling on the subject. For example, you may have been using Type B color film and 3200K studio lights indoors and wish to make pictures with the light from photofloods without changing your film. In this case you would need a conversion filter.

To convert daylight to match the balance of Type A, Type B, or Type F color-transparency films, yellowish pink [warming] conversion filters are used.

To convert flood or flash illumination to match the balance of daylight type transparency films, blue [cooling] conversion filters are used.

Conversion filters are most frequently used with color-transparency film. [The special requirements of color-negative films will be covered in detail in

later tables.] Here is a list of conversion filters and the type of transparency film and light with which they are commonly used.

Warming [yellowish pink] conversion filters
85 Used with Type A film in daylight
85B Used with Type B film in daylight

Cooling [blue] conversion filters
80A Used with daylight film and 3200K floods
80B Used with daylight film and 3400K photofloods
80C Used with daylight film and white flashbulbs, *except* AG1, M3, and M5
80D Used only with daylight film and AG1, M3, and M5 white flashbulbs

Like conversion filters, light-balancing filters also are supplied in yellowish, warming types [designated as the 81 Series] and in bluish, cooling types [designated as the 82 Series]. However, light-balancing filters are paler than conversion filters, and the amount of color change caused by them generally is less than you get with a conversion filter. Also, their bluish and yellowish colors are not exactly the same hues as those in the conversion filters.

While the original purpose of light-balancing filters was to adjust the color quality of light for natural color rendition, they can be used in color photography in any situation where you desire either a warming or cooling effect.

A number of manufacturers offer conversion and light-balancing filters. They include Enteco, Gallinger, Kodak, Spiratone, Tiffen, and Walz.

Ednalite and Harrison filters

Two filter manufacturers–Ednalite and Harrison–offer series of filters that are similar in purpose to conversion and light-balancing filters.

Ednalite Color-Toning Filters are available in six progressively warmer hues [designated CTY-1 through CTY-6] and in four progressively cooler hues [designated CTB-1 through CTB-4]. Ednalite also manufactures stronger-tinted filters that are approximately equivalent to the conversion filters we've listed above.

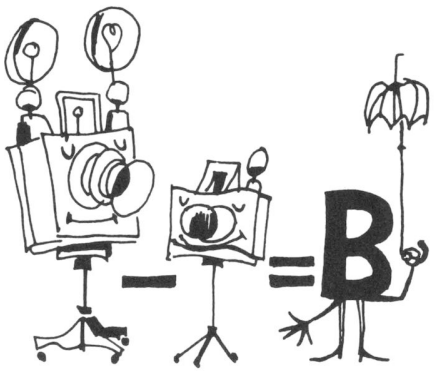
Harrison Light-Corrector Discs include a series of eleven warming filters [designated with the letter C before the number] and a series of eleven cooling filters [designated by the letter B]. We've listed only those that are most nearly equivalent to light-balancing and conversion filters.

The following table shows the *approximate* relationship between light-balancing and conversion filters and the Ednalite and Harrison systems. This table is based on filter use and is intended as a rough guide only. It doesn't imply that a filter in one system or group has exactly the same color or will give precisely the same effect as an equivalent filter in another group. Thus, while an 85 conversion and a Harrison C-4 can be used for the same purpose, the results may not be identical–although acceptable in both cases.

Approximately equivalent color filters

	Color of filter	Conversion and light-balancing filters	Ednalite filters	Harrison filters
Warmer	yellowish pink	85B	Chrom-B	C-5
		85	Chrom-A	C-4
		85C	Chrom-F	C-2
	pale yellowish	81EF	CTY-6	C-1
		81D	CTY-5	C-3/4
		81C	CTY-4	C-1/2
		81B	CTY-3	C-1/4
		81A	CTY-2	C-1/8
		81	CTY-1	C-1/8
	pale bluish	82	CTB-1	B-1/8
		82A	CTB-2	B-1/4
		82B	CTB-3	B-1/2
		82C	CTB-4	B-1/2
Cooler	blue	80C	80C	B-2
		80B	80B	B-4

The decamired system



This system, originated in Europe, uses two series of filters–one bluish [B] and the other reddish [R]–which vary in degree of density. These filters are used for the same purposes as the conversion or light-balancing filters we've already discussed in this section. The decamired system offers the advantage of enabling you to find quickly the filter you need by referring to one table.

In this system a *decamired number* is assigned to each film type and each light source, as you can see on the following chart. To find the decamired filter you need for any combination of film type and light source, *subtract the smaller number from the larger one.* The number you get is the number of the decamired filter you should use. Use a B filter of that number if the light source has a *higher* decamired number than the film does. Use an R filter of that number if the light source has a *lower* decamired number than the film does.

For example, assume you have a brand of daylight color-transparency film in your camera and want to shoot by light from a 3200K studio bulb. Look at the chart below, and you'll see that 3200K bulbs have a decamired number of 31 and daylight type color film has a decamired number of 18.

Subtract 18 from 31 and you get 13–the number of the decamired filter you should use. The decamired number for the light source is higher than the decamired number for the film type. This means you need a filter from the B [bluish] series. Therefore the decamired filter you should use is the B13.

Two or more decamired filters *of the same color* may be used in combination to give you the density required. However, never combine decamired filters of different colors.

Sometimes you may not have a filter or combination of filters that gives you exactly the number you need. In this case, you'll usually be safe if you use a filter or combination that is up to *1 1/2 numbers less* than the required number. For example, say you need a decamired R5 filter but only have an R3 and an R1 1/2. You could combine the two for the equivalent of R4 1/2 and get acceptable results.

Decamired numbers for light sources and types of color film

	Light source	Decamired number	Color film type	Decamired number
Warmer	candle or kerosene lamp	52		
	household electric light bulb 40 to 60 watts	36		
	household electric light bulb 100 watts	35		
	3200K studio lights	31	Type B	31
	SM and SF [gas-filled] flashbulbs	30		
	3400K photofloods and "warm white" fluorescent bulbs	29	Type A	29
	white [3800K] flashbulbs	26		
	"cool white" fluorescent bulbs	22		
	yellowish sunlight—early morning or late afternoon	20		
	average sunlight	18	Daylight color transparency and color negative*	18
	blue flashbulbs and electronic flash	16		
	heavily overcast sky	15		
Cooler	light overcast sky or open shade with blue sky	14		

*Including Agfacolor CN17, Ektacolor Professional, Type S, and Kodacolor-X, but *not* Ektacolor Type L.

Filter factors for decamired filters

Decamired filter	Exposure increase in *f* stops
R1, B1, R3	1/3
R6, B3	1/2
R9 [R6 plus R3 equals R9]	3/4
R12, B6	1
R15 [R12 plus R3 equals R15]	1 1/3
R18 [R12 plus R6 equals R18], B9	1 1/2
B12	2
B15 [B9 plus B6 equals B15]	2 1/2
B18 [B12 plus B6 equals B18]	3

Decamired filters available from various manufacturers

Brand of filter	Decamired filter number*							
	1	1 1/2	2	3	5	6	11	12
Enteco	X			X		X		X
Hasselblad		X		X		X		X
Lifa		X		X		X		X
Rollei	X		X		X		X	
Spiralite				X		X		X
Tiffen		X		X		X		X

*Available in R and B series.

Choosing the right light-balancing or conversion filter

The two tables which follow list color films and the conversion or light-balancing filters you need to use when exposing these films with various light sources. We've provided information on all the color films listed in Section 4 —color-transparency films on one chart and color-negative films on the other.

To use the charts, first locate your film in the left-hand column, then look at the top of the chart to find the column for the light source you plan to use. The filter recommendation is given in boldface, and the adjusted exposure index is listed under it in regular type.

For example, the recommendation for Daylight Type Kodachrome II used with photofloods is given this way:

80B
8

This means you should use an 80B filter and an exposure index of 8.

"N.R." means the film is not recommended for use with that particular light source.

In some cases, you will need to use *two* filters in combination to get the proper color balance. For instance, 80B + 82A on the chart indicates that both an 80B and an 82A filter must be placed in front of the lens at the same time to give the desired effect.

If you're using an Ednalite or Harrison filter, refer to the earlier table of equivalent filters to see which filter of the type you're using most closely matches the recommended conversion or light-balancing filter.

Notice that Type A and Type B transparency films can be converted to daylight use with relatively little loss in film speed, but that when you convert daylight films for use with photofloods or 3200K studio lights, considerable loss of speed results. Therefore, if you plan to mix floodlight and daylight shooting on the same roll, it's generally best to choose a Type A or Type B film and then use a daylight conversion filter for your outdoor shooting.

Conversion and light-balancing filters for color-negative films

Film	Light source				
	Average daylight	Electronic flash	Blue flashbulb	3400K photoflood	3200K studio light
Daylight, electronic flash, or blue flashbulb type					
Agfacolor CN17	**no filter** 40	**no filter** 40	**no filter** 40	**82A** 32	**82C** 20
Ektacolor Professional Type S**	**no filter** 100	**no filter** *	**no filter** *	**80B** 32	**80A** 25
Kodacolor-X	**no filter** 80	**no filter** 80	**no filter** 80	**80B** 25	**80A** 20
Type B					
Ektacolor Type L***	**85** 64 [at 1/10 second]	N.R.	N.R.	**81A** 64 [at 1 second]	**no filter** 64 [at 5 seconds]

*See guide numbers on film data sheet.
**A film for use at exposures of 1/10 second or shorter.
***A sheet film for use at exposures of 1/10 second to 60 seconds.

Conversion and light-balancing filters for color-transparency films

Film	Light source					
	Average daylight	Electronic flash	Blue flashbulb	White [3800K] flashbulb	3400K photoflood	3200K studio light
Daylight type						
Agfachrome Professional CT	**no filter** 50**	**81A** 50**	**no filter** 50**	**81B + 82C** 50**	**80C + 82A** 12**	**80B** 10**
Agfachrome CT18	**no filter** 50	**81A** 50*	**no filter** 50*	**82B + 82C** 50*	**80C + 82A** 12	**80B** 10
Anscochrome [sheet film]	**no filter** 32	**81A** 32*	**no filter** 32*	**80C** or **80D**† 32*	**80B** 12	**80A** 8
Anscochrome 50	**no filter** 50	**no filter** 50*	**no filter** 50*	**80C** 50*	**80B** 20	**80A** 16
Anscochrome 100	**no filter** 100	**no filter** 100*	**no filter** 100*	**80C** 100*	**80B** 40	**80A** 32
Anscochrome 200	**no filter** 200	**no filter** 200*	**no filter** 200*	**80C** 200*	**80B** 80	**80A** 64
Dynachrome 25	**no filter** 25	**no filter** 25*	**no filter** 25*	**80C** or **80D**† 25*	**80B** 12	**80A** 8
Ektachrome Professional	**no filter** 50**	**no filter** 50*	**no filter** 50*	**80C** or **80D**† 50*	N. R.	N. R.
Ektachrome-X	**no filter** 64	**no filter** 64*	**no filter** 64*	**80C** or **80D**† 64*	**80B** 25	**80A** 16
High Speed Ektachrome	**no filter** 160	**no filter** 160*	**no filter** 160*	**80C** or **80D**† 160*	N. R.	N. R.
Kodachrome II	**no filter** 25	**no filter** 25*	**no filter** 25*	**80C** or **80D**† 25*	**80B** 12	**80A** 8
Kodachrome-X	**no filter** 64	**no filter** 64*	**no filter** 64*	**80C** or **80D**† 64*	**80B** 25	**80A** 16
Peruchrome	**no filter** 32	**no filter** 32*	**no filter** 32*	**80C** or **80D**† 32*	**80B** 16	**80A** 12

*Base guide numbers for electronic flash or *blue* flashbulbs on this exposure index. With *white* flashbulbs, use this exposure index and the guide numbers of the equivalent *blue* flashbulb, or use guide numbers given in the film data sheet.

**Actual exposure index may vary with different batches of film. See data sheet accompanying film for the exposure index to use and special filter recommendations for that batch.

†Use 80D with zirconium-filled flashbulbs [AG1, M3, M5]; 80C with all others.

Conversion and light-balancing filters for color-transparency films [*continued*]

Film	Light source					
	Average daylight	Electronic flash	Blue flashbulb	White [3800K] flashbulb	3400K photoflood	3200K studio light
Type A						
Kodachrome II Professional Type A	**85** 25	N. R.	N. R.	**81C** **	**no filter** 40	**82A** 32
Type B						
Agfachrome CK20	**85B** 50	N. R.	N. R.	**81D** **	**81A** 40	**no filter** 80
Agfachrome Professional CK	**85B** 40†	N. R.	N. R.	**81D** **	**81A** 50†	**no filter** 64†
Anscochrome Tungsten [sheet film]	**85B** 20	N. R.	N. R.	**81D** **	**81A** 20	**no filter** 25
Anscochrome T/100	**85B** 80	N. R.	N. R.	**81D** **	**81A** 100	**no filter** 100
Ektachrome Type B	**85B** 25†	N. R.	N. R.	**81C** **	**81A** 25†	**no filter** 32†
High Speed Ektachrome Type B	**85B** 80	**85B** 80*	N. R.	**81C** **	**81A** 100	**no filter** 125

*Base guide numbers for electronic flash on this exposure index. With flashbulbs, use this exposure index and the guide numbers of the equivalent *blue* flashbulb, or use guide numbers given in the film data sheet.
**See guide numbers in film data sheet.
†Actual exposure index may vary with different batches of film. See data sheet accompanying film for the exposure index to use, and special filter recommendations for that batch.

Color-compensating or CC filters

CC filters are supplied in various pale tints of red, green, blue, magenta, yellow, and cyan. They often are used to adjust the color quality of the light when working under fluorescent lamps, when making color prints and color-slide duplicates, and when taking pictures with electronic flash and certain professional roll and sheet color films to get precise color balance. [CC filter data generally is packed with these films.]

The filters discussed here are intended for use either on your camera when taking a color picture or on an enlarger when making a color print. [Acetate Ansco CC and Kodak CP filters, which are primarily intended for color *printing*–not color shooting–are discussed in the section on processing color.]

CC filters also are often used in experimental photography to produce unusual color effects. As can be seen from the table that follows, a large selection of colors and densities is available, allowing for much play of the imagination in their application.

In general, CC filters are purchased in the form of inexpensive gelatin sheets. However, glass-mounted CC filters can be specially ordered from some manufacturers if you plan to make repeated use of a filter or group of filters.

Kodak color-compensating filters

Density	Yellow [absorbs blue]	Exposure increase in *f* stops*	Magenta [absorbs green]	Exposure increase in *f* stops*	Cyan [absorbs red]	Exposure increase in *f* stops*
.025	CC-025Y	–	CC-025M	–	CC-025C	–
.05	CC-05Y	–	CC-05M	1/3	CC-05C	1/3
.10	CC-10Y	1/3	CC-10M	1/3	CC-10C	1/3
.20	CC-20Y	1/3	CC-20M	1/3	CC-20C	1/3
.30	CC-30Y	1/3	CC-30M	2/3	CC-30C	2/3
.40	CC-40Y	1/3	CC-40M	2/3	CC-40C	2/3
.50	CC-50Y	2/3	CC-50M	2/3	CC-50C	1
Density	Red [absorbs blue and green]	Exposure increase in *f* stops*	Green [absorbs blue and red]	Exposure increase in *f* stops*	Blue [absorbs red and green]	Exposure increase in *f* stops*
.025	CC-025R	–	CC-025G	–	CC-025B	–
.05	CC-05R	1/3	CC-05G	1/3	CC-05B	1/3
.10	CC-10R	1/3	CC-10G	1/3	CC-10B	1/3
.20	CC-20R	1/3	CC-20G	1/3	CC-20B	2/3
.30	CC-30R	2/3	CC-30G	2/3	CC-30B	2/3
.40	CC-40R	2/3	CC-40G	2/3	CC-40B	1
.50	CC-50R	1	CC-50G	1	CC-50B	1 1/3

*These values are approximate. For critical work, they should be checked by practical test, especially if more than one filter is used.

Kodak color-compensating filters are supplied in the form of gelatin squares or [on special order] cemented between glass. In the latter case, filters may be ordered either in standard "series" sizes or in the form of 2-, 3-, or 4-inch squares for use in special Kodak filter holders. Allow several weeks for the delivery of glass-mounted CC filters.

Agfa color-compensating filters

Agfa CC filters are supplied in magenta [M], cyan [C], and yellow [Y], and in densities of .05, .10, .20, .30, .40, .50, and .99.

Sets of Agfa CC filters contain twenty-four filters. In addition to the above densities the Agfa CC filter sets contain one extra CC filter in .99 density of each of the three colors–cyan, magenta, and yellow.

They are available only in gelatin form and in 2 3/4x2 3/4-inch [70x70-mm] and 4 3/4x4 3/4-inch [120x120-mm] sizes.

Spiratone CC filters

These acetate filters are supplied in six densities ranging from CC05 to CC100 and in three colors–magenta, yellow and cyan. They are available in 2x2 mounts with a 4x4-cm opening, to fit in front of small enlarging lenses, and in 3 1/2-inch squares and 4 3/4x6-inch rectangles in enlarger color heads.

Tiffen CC filters

These are supplied in standard "series" sizes, glass-mounted, in densities from CC05 to CC110. They are available in yellow, magenta, cyan, blue, red, green.

Note: Kodak, Ansco, Tiffen and Spiratone filters having the same density number are similar in action, but not necessarily exactly alike. When adopting filters for your work, stick to one brand if you want consistent results.

The Agfa CC system is different. For example: an Agfa CC10Y filter will have a different density and peak transmission from other CC10Y filters. A conversion chart showing the relationship between Agfa and Kodak CC filters is available from Agfa-Gevaert.

Polarizing filter

A polarizing filter is valuable in color photography because it enables you to darken blue sky *without affecting any other colors in a scene.* Just as in black-and-white photography, the amount of sky-darkening effect you get depends on two things–the angle of the filter and the portion of the sky you are photographing. The effect of the polarizing filter at any angle is greatest when you're photographing a sky area at right angles to the sun. The filter has practically no sky-darkening effect if you point it directly toward or away from the sun. Also, it won't darken overcast sky.

The polarizing filter also can be used in color shooting, as in black and white, to reduce reflections from shiny nonmetallic objects–water, glass, polished wood, etc. It can help you get richer colors of foliage and penetrate light atmospheric haze.

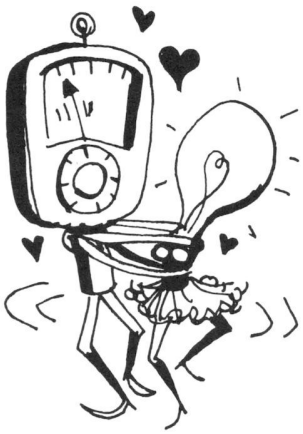
When using a polarizing filter and color film, increase your exposure about three times [one and one-half stops].

Neutral density filters

These gray filters have little or no effect on the color rendition. They may be used in color photography for the same purposes described in the section on filters for black-and-white photography under the heading "Neutral Density Filters."

6

Exposure meters and methods



Exposure control and the use of exposure meters are demonstrated in many places in your Course. Here we'll cover some of the special and more technical aspects of the subject.

Remember the "correct" exposure is the one that gives you the effect you want. It is determined by *duration*–the length of time your shutter remains open [or the length of the flash, in the case of speedlight or open flash]–and by the *lens aperture.*

Different combinations of shutter speed and aperture can produce the same exposure–but not the same visual effect. So keep in mind the effect you want–shallow depth of field or maximum sharpness, stopped action or blurred action –when you set your camera controls.

How a selenium-cell exposure meter works

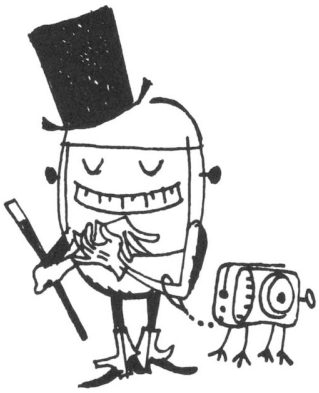
An exposure meter is a device for measuring the *intensity* of light. The most common type uses a light-sensitive selenium cell to accomplish this. Here's what happens:

1. Light [either reflected from the subject in the case of a reflected-light meter or direct from the source in the case of an incident-light meter] strikes the light-sensitive selenium cell.
2. The light's energy is converted into minute amounts of electrical energy which travel through a highly sensitive microammeter.
3. The microammeter causes a pointer to move across a scale. The stronger the current passing through the microammeter, the more the pointer moves.

Refinements may be added to the meter to make it more useful–various dials and scales, grids, baffles, light-collecting disks or spheres, etc. But the light-sensitive cell remains the heart of the meter.

Special exposure meters

Cadmium-sulfide meter

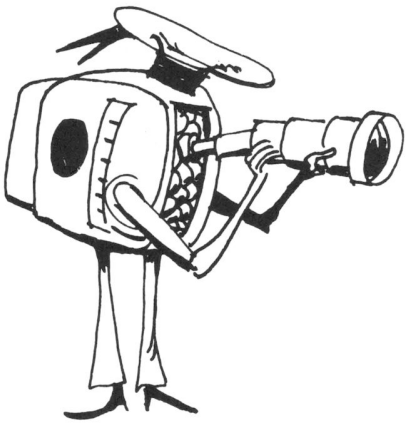


This is a relatively new type of exposure meter. Its main advantage over the older, but still popular, selenium-cell meter is the possibility of making cadmium-sulfide meters very sensitive to light.

Unlike selenium-cell meters, in which the cell itself generates minute amounts of electric current, the cadmium-sulfide cell *merely regulates the amount of current fed to the sensitive microammeter.* This current–much stronger than that produced by a selenium cell–is supplied by one or more tiny mercury batteries in the meter housing. The cadmium-sulfide cell acts as a sort of rheostat–the more intense the light striking the cell, the more current is allowed to flow through the microammeter–and the greater the movement of the needle. When less intense light strikes the cell, less current flows, and the needle moves less.

A disadvantage of many cadmium-sulfide meters [or *CdS meters* as they sometimes are called] is the fact that their sensitivity to light of different colors is not as uniform as that of a selenium cell. This can lead to errors in color photography, where very exact exposure is necessary. Some meter manufacturers compensate for this to an extent by placing filters across the meter cell. In the case of at least one manufacturer, both a selenium and a CdS cell are incorporated in the same meter housing. The selenium cell is used for the majority of readings; the CdS cell only for very low light readings.

Spot meter



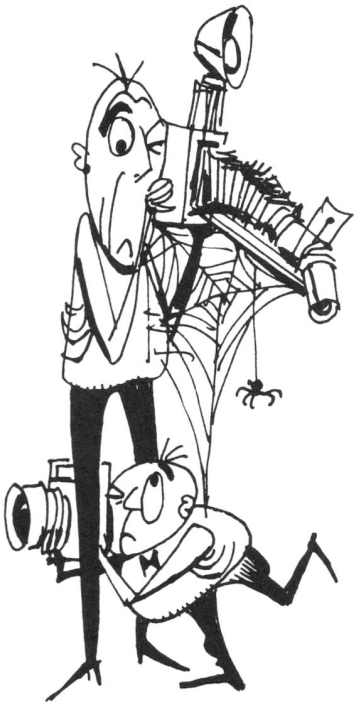
The average exposure meter "sees" an angle of view roughly equal to that of the average camera lens. While this is sufficiently selective for most work, there may be occasions when you need the ability to read only a small portion of the subject from camera position. For example, you might not be able to get close to a distant subject–a case in point would be if you were photographing someone on a stage from a seat far back in the theater–or it might be dangerous to get too close. In such situations meters which measure a very narrow angle of view–often called *spot meters*–can be very useful.

Spot meters include both photoelectric types and types that require you to match the intensity of two spots by visual comparison.

The photoelectric meters generally use CdS cells. Their sensitivity is fairly high, but not as high as might be expected from the use of this cell. The reason is that only a portion of the cell is used to obtain a reading of a small area.

The nonphotoelectric type of spot meter can be used to take exposure readings in almost any place the eye can see. In using this kind of meter, you look through a telescopic eyepiece at the scene. In the center of the eyepiece you see a spot. The usual procedure is to place this spot over a white or light area in the scene. By means of a rheostat control you can regulate the intensity of this spot until it matches the tone of the area over which it is superimposed. Then you read a dial to see what exposure you require. The color of the spot may be changed from a yellowish white [used for artificial-light readings] to a bluish white [for daylight readings] or vice versa, by means of filters built into the meter body.

Reciprocity failure

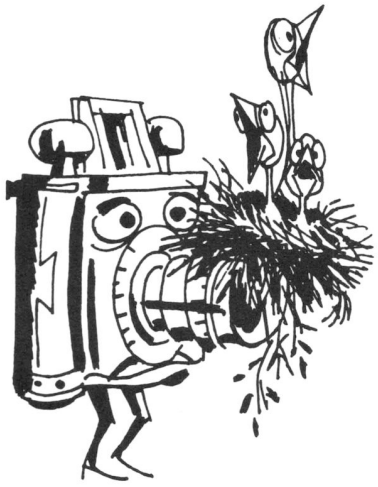


When light-sensitive materials such as photographic films and papers are given exposures that are much *longer* or much *shorter* than normal, a loss of efficiency may result. For example, very long exposures at small apertures or at low light levels, or very short exposures [as with electronic flash and high-shutter-speed action photography] may make film behave in a somewhat different manner than usual. An apparent loss in film speed [called *reciprocity failure*] and a lowering of contrast may take place, resulting in underexposure. In the case of color film there also may be a change in the film's color balance, resulting in unnatural-looking colors.

The effect is somewhat analogous to what happens when a housewife fries eggs. The flavor and appearance of the eggs won't be the same if the eggs are fried quickly over a large flame [short exposure] as when they are fried slowly over a low fire [long exposure].

With moderately long or short exposures the effects of reciprocity failure usually will not be serious enough to detract from the pictorial value of your photographs. With relatively long exposures–of several seconds' or minutes' duration–in black-and-white photography, you may need to give extra exposure plus increased development to maintain desired contrast. In the case of color film, changes in development seldom are recommended by the manufacturer. However, increased exposure and the use of filters to restore color balance may be called for if exposures are considerably longer or shorter than normal.

For most accurate results, *consult the manufacturer of the film you are using* for recommendations regarding reciprocity failure and color shift. In corresponding with a manufacturer, give the following information: expected length of the exposure, development to be given the film, emulsion number, and expiration date of the film, and–if you're planning to use color–the light source by which you intend to expose the film. Also indicate the kind of subject you plan to photograph.



The importance of a clean lens

If you want to get maximum light transmission from your lens, make sure it isn't coated with dust or grime. Also protect it with a lens cap when you're not using it and always handle the lens carefully so that it doesn't become covered with scratches.

Aside from loss of light, which can give less than the calculated exposure, dirty and scratched lenses often are the cause of fuzzy, flat, and foggy-looking pictures. With color film, light scattered by dust may produce an undesirable color cast in your slides or prints.

Dirty lenses should be cleaned carefully using a *soft, lint-free cloth* or special *photographic lens tissue only*. Dirt accumulated between lens elements is best removed by the camera maker, or by your local camera repair shop.

Shutter efficiency

Often the actual speeds of a camera's shutter do not correspond exactly to those marked on the shutter-speed dial. For example, a shutter marked with speeds of 1/30, 1/60, and 1/125 second may prove on actual test to give exposures of 1/20, 1/50, and 1/90 second respectively, or some other speeds than the marked ones.

This discrepancy may be caused by the shutter's springs losing some of their tension, or by dirt and corrosion accumulating in the shutter mechanism. However, there may be some variation from marked shutter speeds even in brand-new shutters, due to the manufacturing tolerances required by mass production techniques.

In many cases the deviation from marked speeds is not serious enough to concern you. If very accurate exposures are important–as in color photography –a repairman can test your shutter and give you a table of the actual rather than the marked speeds. In general, the higher shutter speeds–say 1/100 or 1/125 second and faster–usually are somewhat slower than indicated. This sometimes can lead to overexposure when shooting at high speeds. If you consistently get overexposed results when using fast shutter speeds, reduce exposure by using a smaller aperture than you otherwise would.

The exposure-value system

Some still cameras use a system of exposure settings called *LVS* [light-value scale] or, more commonly, *EVS* [exposure-value system]. The basic principle of the system is to use a single number to designate a certain amount of exposure, regardless of what combination of aperture and shutter speed was used to obtain it. This offers certain advantages in simplicity and convenience, as we'll explain.

The EV numbers usually range from 2 to 18. The low numbers indicate considerable exposure; the high numbers indicate less exposure. Going up the scale from low to high numbers, each EV number indicates an exposure just half that of the preceding number. For example, EV 10 is half the exposure value of EV 9, EV 15 is half the exposure value of EV 14, and so on.

How the EV system works

The EV system works like this: You take a meter reading to determine the appropriate EV number you need for correct exposure. [Many meters are marked in EV numbers, in addition to giving readings in terms of shutter speeds and lens apertures.] Then you set a dial or ring on your camera's exposure control to the indicated EV number, and lock the setting in place. This engages a cross-coupling device which links together both your shutter-speed and aperture controls. Changing one automatically changes the other–in a way that keeps the exposure constant.

For example, suppose your meter tells you to use EV 14. As you can see in the table on page 68, this is the amount of exposure that 1/125 second at *f*/11 would give you.

If you set your camera for EV 14 and engage the cross-coupling device, setting your shutter-speed control for 1/125 second will automatically set your aperture control at *f*/11. Now suppose you want to close down a full stop–to *f*/16–for greater depth of field. This will automatically require you to change the shutter speed to 1/60 second. Exposure remains the same because 1/60 second at *f*/16 lets in exactly the same total amount of light as does 1/125 second at *f*/11.

On the other hand, say you increase shutter speed to 1/500 second to stop more action. In this case, the aperture setting will be changed to *f*/5.6, which also maintains the exposure–EV 14. The total number of different combinations available is limited only by the range of *f* stops and shutter speeds on your camera.

Advantages of the EV system

There are two principal advantages offered by the EV system:

1. It simplifies reading a meter. Instead of choosing between various combinations of *f* stops and shutter speeds and then setting your camera accordingly, you just read one number and set one control.
2. It simplifies camera operation. Once the EV number is locked in place, you maintain constant exposure. Any change in shutter speed will automatically be compensated for by a corresponding change in lens aperture.

Most cameras with EV numbers allow you to disengage the cross-coupling device and set the lens aperture and shutter speed independently of each other. With this arrangement you are free to use EV numbers when it's to your advantage or to bypass them when it's not, as when you want to change shutter speed only, or aperture only.

What EV numbers mean

Following each EV number are different aperture and shutter-speed combinations that give the equivalent exposure value.

EV number	Equivalent exposure value	
2	1 second at *f*/2	
3	1 second at *f*/2.8	1/2 second at *f*/2
4	1 second at *f*/4 1/2 second at *f*/2.8	1/4 second at *f*/2
5	1 second at *f*/5.6 1/2 second at *f*/4	1/4 second at *f*/2.8 1/8 second at *f*/2
6	1 second at *f*/8 1/2 second at *f*/5.6 1/4 second at *f*/4	1/8 second at *f*/2.8 1/15 second at *f*/2

What EV numbers mean [*continued*]

EV number	Equivalent exposure value	
7	1 second at *f*/11 1/2 second at *f*/8 1/4 second at *f*/5.6	1/8 second at *f*/4 1/15 second at *f*/2.8 1/30 second at *f*/2
8	1 second at *f*/16 1/2 second at *f*/11 1/4 second at *f*/8 1/8 second at *f*/5.6	1/15 second at *f*/4 1/30 second at *f*/2.8 1/60 second at *f*/2
9	1 second at *f*/22 1/2 second at *f*/16 1/4 second at *f*/11 1/8 second at *f*/8	1/15 second at *f*/5.6 1/30 second at *f*/4 1/60 second at *f*/2.8 1/125 second at *f*/2
10	1/2 second at *f*/22 1/4 second at *f*/16 1/8 second at *f*/11 1/15 second at *f*/8	1/30 second at *f*/5.6 1/60 second at *f*/4 1/125 second at *f*/2.8 1/250 second at *f*/2
11	1/4 second at *f*/22 1/8 second at *f*/16 1/15 second at *f*/11 1/30 second at *f*/8	1/60 second at *f*/5.6 1/125 second at *f*/4 1/250 second at *f*/2.8 1/500 second at *f*/2
12	1/8 second at *f*/22 1/15 second at *f*/16 1/30 second at *f*/11 1/60 second at *f*/8	1/125 second at *f*/5.6 1/250 second at *f*/4 1/500 second at *f*/2.8
13	1/15 second at *f*/22 1/30 second at *f*/16 1/60 second at *f*/11	1/125 second at *f*/8 1/250 second at *f*/5.6 1/500 second at *f*/4
14	1/30 second at *f*/22 1/60 second at *f*/16 1/125 second at *f*/11	1/250 second at *f*/8 1/500 second at *f*/5.6
15	1/60 second at *f*/22 1/125 second at *f*/16	1/250 second at *f*/11 1/500 second at *f*/8
16	1/125 second at *f*/22 1/250 second at *f*/16	1/500 second at *f*/11
17	1/250 second at *f*/22	1/500 second at *f*/16
18	1/500 second at *f*/22	

Exposures for subjects after dark

The following chart is intended as a very approximate guide only–a starting point for your own experimenting. Exact exposure advice is impossible to give here because the brightness of afterdark illumination can vary so greatly from one subject to another. Also, the exposure that's best for a picture depends partly on the effect you want in terms of color, contrast, and detail.

To use this chart, first locate the exposure index column for the film you are using. [If your exposure index doesn't exactly match any of those listed, use the nearest one.] Then see the suggested exposure for the type of subject you plan to photograph. Where two *f* stops are given, *f*/2-*f*/2.8, for example, set your aperture control halfway between them. We suggest you bracket your exposures, if time allows. Take a picture at two times your base or starting exposure, then at one half this exposure. Next, take a picture at four times and then at one fourth this exposure. Bracketing is particularly advisable with color-transparency film, which has relatively little exposure latitude.

When shooting in color, a Type A or Type B color-transparency film gives the most natural rendition of colors in afterdark scenes illuminated by floods, spots, street lights, store lights, and other sources of incandescent illumination and *warmer* types of fluorescent light. If you want warmer colors for your purpose, use a daylight-type transparency film instead. Scenes illuminated by *cooler* types of fluorescent light look most natural when shot on daylight-type film. If you want a bluer [colder] effect, use a Type A or B film.

For pictures taken at a shutter speed of less than 1/25 second or 1/30 second, it's generally advisable to use a tripod.

Chart of suggested afterdark exposures

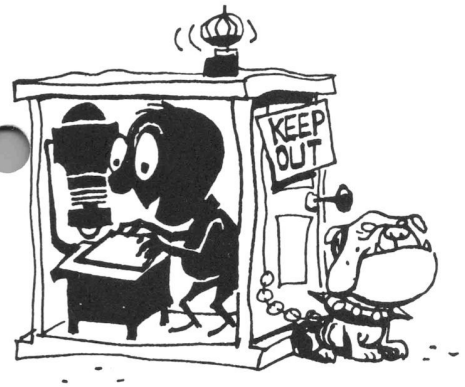
Subject	Exposure index				
	25 – 32	50 – 64	80 – 125	160 – 200	400 – 500
	Exposure				
fireworks–bright, nearby displays	1/60 second *f*/5.6 – *f*/8	1/60 second *f*/8 – *f*/11	1/60 second *f*/11 – *f*/16	1/60 second *f*/16	1/125 second *f*/16
fireworks–bursts in the sky [use open shutter to record several bursts]	2 seconds *f*/11	2 seconds *f*/16	1 second *f*/11	1 second *f*/16	1 second *f*/16–*f*/32
close-ups of neon or other lighted signs	1/15 second *f*/2.8	1/30 second *f*/2 – *f*/2.8	1/60 second *f*/2 – *f*/2.8	1/60 second *f*/2.8	1/60 second *f*/4
burning buildings, campfires	1/15 second *f*/2.8	1/30 second *f*/2 – *f*/2.8	1/60 second *f*/2 – *f*/2.8	1/60 second *f*/2.8	1/60 second *f*/4

Afterdark exposures [*continued*]

Subject	Exposure index				
	25 – 32	50 – 64	80 – 125	160 – 200	400 – 500
	Exposure				
close-ups of store windows [use an exposure meter if practical]	1 second *f*/8	1/2 second *f*/8	1/15 second *f*/4	1/30 second *f*/2.8	1/30 second *f*/4
street scenes at night with bright signs and store windows [use 1 for less motion blur, 2 for greater depth of field]	[1] 1/4 second *f*/2.8 [2] 2½ seconds *f*/8	[1] 1/8 second *f*/2.8 [2] 1 second *f*/8	[1] 1/15 second *f*/2.8 [2] 1/2 second *f*/8	[1] 1/30 second *f*/2.8 [2] 1/4 second *f*/8	[1] 1/60 second *f*/2.8 [2] 1/8 second *f*/8
Christmas lighting [outdoors]	20 seconds *f*/8	10 seconds *f*/8	7 seconds *f*/8	3 seconds *f*/8	3 seconds *f*/11
floodlighted buildings, monuments, fountains	30 – 60 seconds *f*/8	15 – 30 seconds *f*/8	10 – 20 seconds *f*/8	5 – 10 seconds *f*/8	2 – 5 seconds *f*/8
moonlit landscapes	5 minutes *f*/8	2½ minutes *f*/8	1 – 1½ minutes *f*/8	1/2 – 1 minute *f*/8	15 – 30 seconds *f*/8

7

Developing and printing for black-and-white films



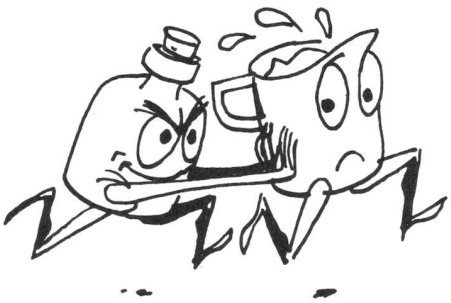
Basic methods of developing and printing are discussed and demonstrated in detail in your lessons. In this section we list some of the specific products available–processing chemicals, papers, etc.–and give additional information about them. Use this section to choose the developer and paper that best fit your needs and to solve some of the practical problems you may encounter in your home darkroom work. We will discuss only *black-and-white* processing here. Color processing is so important it deserves a special section to itself.

Film developers

Photographic film consists of a *base*–usually a flexible acetate material–coated with a light-sensitive emulsion composed largely of minute crystals of silver salts [silver halides, more technically speaking] suspended in gelatin. When *exposed* film is placed in a chemical solution called the *developer*, the developer converts the particles of silver halide that have been affected by light into black, metallic silver to form the negative image. The developer also will work on the unexposed particles of silver, but it does so at a much slower rate. Therefore, with normal development, only a relatively small amount of black metallic silver [called *fog density*] is formed in the unexposed areas.

There are many different formulas for developer solutions. Some developers are prepared in packaged form by the manufacturer, as powders or as concentrated liquid you mix with water to make a working solution. Others can be mixed by the photographer from various chemical ingredients. However, practically all formulas include the following essential ingredients: [1] a developing agent, [2] an accelerator, [3] a preservative, [4] a restrainer, and [5] water.

The *developing agent* [also called the *reducing agent*] is the active ingredient that actually does the work of converting the exposed grains of



silver halide into black metallic silver. Metol or elon, phenidone, and hydroquinone are chemicals often used for this purpose.

The *accelerator* is an alkali added to make the developing agent sufficiently active. It speeds up the developing process. Sodium carbonate, borax, and sodium or potassium hydroxide are commonly used as accelerators.

A *preservative* is needed to give the mixed solution better keeping qualities and a longer useful life. [Developing solutions tend to absorb oxygen from air and water and thus lose their effectiveness.] Sodium sulfite often is used as a preservative.

A *restrainer* may be added to control the developing agent and hold it back from acting on the unexposed particles of silver halide. Potassium bromide often is used for this purpose.

Four factors which affect development

In your own darkroom work, keep clearly in mind these four basic things that will affect development.

Time of developing: When you place your exposed film in the developer, the solution soaks into the emulsion and begins to change the exposed particles of silver halide into black, metallic silver. In the shadow areas, there are relatively few exposed particles, and soon these all are converted to metallic silver. But as the developer penetrates deeper into the emulsion it continues to work on the highlight areas, where the exposed particles are much more numerous. As developing goes on, the negative's overall *density* increases. That is, it becomes more opaque. But also its *contrast* increases, because the highlight areas continue to build up after the shadow areas have slowed down.

However, if developing goes on long enough, a point is reached where *all* the exposed particles of silver halide are converted into metallic silver. Then the developer continues to act on the *unexposed* particles. At first, this causes a veil or "fog" over the highlight areas of the negative. As the fog increases, the contrast in the negative begins to decrease. Eventually, if you allowed developing to go on long enough, the entire negative would turn black.

Obviously, the developing time must be long enough to give you adequate density and contrast, but not so long that fog becomes a problem. [As developing goes on, the negative also tends to become more grainy and less sharp—another good reason to avoid overdevelopment.]

In reading technical data sheets for some developers, you may see references to *gamma*. For example, you may be told that you need to use a developing time of ten minutes to produce a gamma of 0.7. For practical purposes, gamma can be taken to mean the negative's *contrast*. A gamma of about 0.6 or 0.7 generally is considered to be a normal amount of contrast for 35-mm and roll films, and a gamma of 0.8 for sheet film.

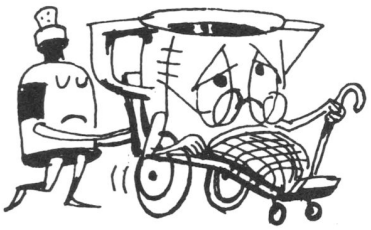
Often, developing times are given as a range: 4-5 minutes, etc. For slightly less contrast, use the shorter time; for slightly more, use the longer.

Temperature of the developer: The temperature of the developing solution is an important consideration. In general, as the temperature increases, so does the rate of development. The warmer the solution, the shorter the time required to reach the ideal degree of development. With most black-and-white developing formulas, the recommended temperature for use is

65 to 70 degrees F. Some developers are designed to give good results over a relatively wide range of temperatures, with different times recommended for the different temperatures. These developers are useful when you must work in a cold or very warm place where the temperature of your water can't be adjusted to the normal 65 to 70 degree F. range. However, if the temperature of the solution becomes *too* high, the emulsion may swell and wrinkle.

Agitation: The proper amount of *agitation* is important, as we emphasized in the lesson on black-and-white photography, if you are to get best results. If you place a roll of film in the developer solution and just let it sit, the developer in contact with the emulsion works itself out–it becomes *exhausted*, in the technical phrase. For this reason, the solution needs to be stirred up from time to time to bring fresh solution in contact with the emulsion.

Age and condition of the developing solution: After a certain amount of use, developing solutions become weaker. Longer developing time must be allowed to get the desired result. Be sure to follow the developer manufacturer's instruction regarding this, too. *Don't process more rolls or sheets of film in the developer than recommended.* It's poor economy if you spoil an important roll of film because you didn't use an adequately fresh developing solution.



Some developers can be used with *replenishers* to extend their working life. A replenisher is a solution that can be added in small quantities to the original working solution to prolong its active life.

Improperly stored solutions become weaker more quickly than do properly stored ones. Keep your solution in dark brown bottles. These should be filled up close to the top and tightly stoppered. Store them away from excessive heat.

A note about 'compensating' developers

There are a number of developers on the market today which give *compensating action* during development. This means that they tend to work less effectively in the heavily exposed, highlight areas than they do in the shadows, thus preventing excessive contrast from building up. They generally are used with slow, "thin-emulsion" films, which are inherently very contrasty, or with other films when the subject and lighting are high in contrast.

The compensating developers are prepared as highly concentrated liquids which are diluted with a considerable amount of water when you make a working solution. The compensating action takes place in the following manner. The diluted developer tends to exhaust itself quickly in the highlight areas where there are many exposed silver particles to reduce. It retains its strength longer in the shadow areas, where there are fewer particles to convert to metallic silver. Thus shadow areas tend to "catch up" to highlight areas.

How to choose a film developer

A great variety of film developers is available in convenient packaged form. We have listed a number of the more widely used brands in the following charts. Some of these developers are designed for general photography–the kind of shooting you'll need to do for most of the assignments in your Course. Others are designed primarily for a special purpose, such as available-light or extremely fine-grain pictures. You should know about these, too, because they can help you do better work in special kinds of photography.

We've classified developers into several groups. These groups are based on their general use, by amateur and professional photographers. The groups are intended only as approximate guides to help you make a more intelligent choice. Often, a developer can't be fitted strictly into one group only, and therefore you'll notice that some developers appear in more than one group.

In general, select a film and developer that complement each other. This is largely a matter of common sense. For example, it's a bit foolish to try for extremely fine grain by shooting on a fast, grainy film and then processing it in a very fine-grain compensating developer.

As we have said, be sure to *read the instructions that come with the developer.* Use the film-speed rating suggested by the *developer* manufacturer, even if this is different from what the film maker recommends. [This doesn't mean the film manufacturer doesn't know his business; it's just that his exposure index is based on a developer with different characteristics from the one you've bought.] Be sure to follow carefully the directions regarding *mixing, diluting, time, temperature, agitation,* and *replenishment.*

A final piece of advice is simply this: The ultimate test of any film-developer combination is the *kind of prints it makes.* Only you can be the judge of this. Your goal should be to find a combination that generally produces negatives you can print easily and well with your particular equipment.

Medium-fine-grain developers

This group includes "workhorse" developers for 35-mm and roll-film photography, such as Kodak D-76–long a standard for comparison tests with other developers–and UFG. They produce medium-fine grain and make good use of the potential speed of the film emulsion. Because some of these developers include metol-hydroquinone as a developing agent, and borax as an accelerator, they are sometimes known as "MQ-borax" developers, for short.

Manufacturer and developer	Available in		Replenisher
	powder	liquid	
Ansco			
Hyfinol	X	X	X
Clayton			
P-20		X	
FR			
X-100		X	
Ilford			
ID-2	X		
Kodak			
D-76	X		X
HC-110		X	X
Plymouth			
Ethol UFG	X	X	X

Fine-grain developers

These developers, designed to produce negatives with fine grain, are most commonly used with 35-mm and roll film. In general, they are somewhat "softer working" than the medium-fine-grain developers listed on page 76. That is, they tend to build up contrast a little less rapidly.

Some fine-grain developers base their action on a special developing agent. For example, Edwal Super 12 and Super 20 use paraphenylene-diamine and Gradol, respectively. Others, such as Best Panthermic 777, Agfa Atomal, and May & Baker Promicrol, have developing agents whose identity is not made public. In some instances, fine grain is achieved by including a *silver solvent* that partially dissolves the silver during development.

These developers vary in performance and capability, and the manufacturer's literature should be read carefully for details. For example, you can use Panthermic 777 over a relatively wide range of temperatures, and Microdol-X is designed to give very sharp results with certain Kodak films.

Manufacturer and developer	Available in		Replenisher
	powder	liquid	
Agfa			
Atomal	X		
Ansco			
Finex-L		X	X
Best			
Panthermic 777	X	X	X
Clayton			
P-60		X	
Edwal			
Super 12		X	
Super 20		X	X
FR			
X-33C		X	X
Ilford			
Microphen	X	X	X
Kodak			
Microdol-X	X	X	X
May & Baker			
Promicrol	X		X

Available-light developers

An available-light developer must be capable of making efficient use of a film's potential speed, and is generally used in combination with a medium-speed or high-speed film.

At one time, most available-light developers tended to build contrast quickly, which frequently resulted in blocked-up highlight areas and considerable grain. Improved formulas today allow you to rate your film considerably higher than its "official" manufacturer's ASA rating, and at the same time avoid excessive contrast and grain. [Notice that some of the developers on this list–Promicrol and Microphen, for example–also are listed as fine-grain developers.] With these developers it is particularly important that you follow the manufacturer's advice regarding film-speed rating and developing procedures.

Manufacturer and developer	Available in		Replenisher
	powder	liquid	
Baumann			
Acufine	X		X
Clayton			
Film-All		X	
Edwal			
FG7 Concentrate		X	
Super 12		X	
Ilford			
Microphen	X	X	X
Kodak			
D-76	X		X
May & Baker			
Promicrol	X		X
Plymouth			
Ethol Type T		X	
Ethol UFG	X	X	X

Compensating developers for thin-emulsion film

These developers are designed primarily for use with relatively slow, very fine-grain, thin-emulsion films such as Kodak Panatomic-X and Adox KB14. Properly used with a thin-emulsion film, these developers can give you the

ultimate in fine grain and image sharpness. Therefore, they often are used with 35-mm and roll films for architectural, scenic, close-up, portrait, and other photography where greatest sharpness and finest grain are desired.

Fine-grain film tends to be contrasty. The "compensating" action of these developers is designed to let you develop good shadow detail without blocking up the highlights. In other words, they are very soft-working developers. For this reason, they sometimes are used with faster films when the subject contrast is extremely great.

These all are available in liquid form and are "one-shot" developers. That is, you mix a batch of working solution fresh each time you process your film, then discard the solution after use. Compensating developers for thin-emulsion films include: Edwal Minicol, FR X-22, Plymouth Ethol TEC, and Tetenal Neofin Blue.

Developers often used with sheet film

These developers generally are used with sheet film, although some of them also may be used with roll film when fine grain is not an important consideration. In general, these developers are designed to give a long full scale of tonal values—an important characteristic for most commercial and portrait photography.

Manufacturer and developer	Available in		Replenisher
	powder	liquid	
Ansco			
Isodol	X		X
Permadol	X		X
Clayton			
P-20		X	
Du Pont			
16-D	X		X
Kodak			
DK-50	X		X
DK-60a	X		X
Polydol	X		X
Plymouth			
Ethol UFG*	X	X	X

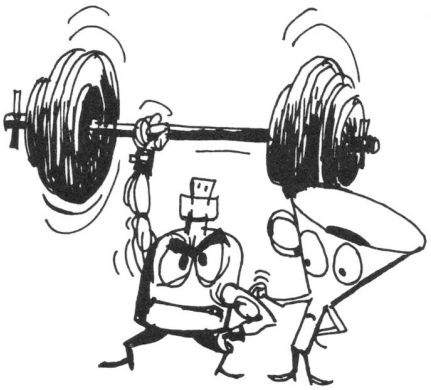
*Also often used with roll and 35-mm film.

Developers for rapid processing

The following developers for sheet film often are used in press photography and other work when *utmost processing speed* is needed. Otherwise, one of the commercial developers listed previously may be used. [With 35-mm and roll film, a developer with fine-grain characteristics usually is preferable.] The fast press developers generally are powerful and contrasty. They include high-speed formulas, such as Ethol 90–capable of developing film in 90 seconds or less –and *paper* developers, such as Dektol and Vividol, which can be used to develop negatives very quickly. UFG, a general-purpose medium-fine-grain developer, also is included here because of its relatively brief processing time.

Manufacturer and developer	Available in		Replenisher
	powder	liquid	
Agfa			
Neutol*	X		
Ansco			
Vividol*	X		
Du Pont			
53-D*	X		
FR			
Paper Developer*		X	
Kodak			
D-19	X		
Dektol*	X		
DK-60a	X		X
HC-110		X	X
Plymouth			
Ethol 90	X		
Ethol UFG	X	X	X

*Primarily a paper developer.



Highly concentrated liquid developers

This special group of developers offers the advantage of unusual versatility. The kind of developing action you get in terms of contrast, developing time, and making good use of film's potential speed is dependent in large measure on how much you dilute the concentrated liquid to make your working solution. For example, a 1¼-ounce bottle of FR X-44 diluted with 16 ounces of water gives a working solution recommended for medium- and high-speed films; diluted with 32 ounces, it gives a working solution for thin-emulsion films. Agfa Rodinal, diluted at 1:100 or 1:75, makes a compensating developer for use with thin-emulsion films, but at 1:50 can be used as an available-light developer with super-fast Isopan Record. In all cases, follow the manufacturer's directions regarding dilution, use, and processing time.

	Manufacturer and developer	Replenisher
	Agfa Rodinal	
	Edwal FG7 Concentrate	
	FR X-44	
	Kodak HC-110	X
	Versatol	
	Plymouth Ethol Type T	

Monobath developers

These are combination developer-fixers which develop and fix the film in one step. They are supplied in liquid form, and are for one-shot use. They include the following: Cormac Unibath CC-1 [for use with medium- and fine-grain films exposed normally], Unibath CC-2 [for high-speed films used for available-light shooting], FR Develofix No. 1, and Ilford Monophen.

FR Instant Fixol or Edwal Hi-Speed Liquid Fix Concentrate can be used with one-shot developers to provide a modified monobath processing. At the end of developing time you add one of these special fixers *directly to the developer*, let the film fix, then discard the solution.

Divided or 'split' developers

In this type of development, the film is first immersed in one solution [called an "A" solution] and then in a second solution [called a "B" solution]. It offers the advantage of giving consistent results and maximum use of the film's potential speed without your having to control time and temperature as exactly as you do with a conventional one-step developer.

Baumann Diafine is a prepared developer for this purpose. It comes in two packages–one with chemicals for mixing the "A" solution, and one with chemicals for the "B." The film is immersed in each solution for a set time. The contrast you get is determined by how the particular film you are using reacts with the developer.

Edwal also offers prepared developers for split development. The "A" solution is made from Edwal FG7 Concentrate and the "B" solution from FG7 Solution B Concentrate. Contrast can be varied by the amount of dilution used in preparing the "A" solution, and by increasing or decreasing the time the film is immersed in it.

Stop baths

The basic purpose of a stop bath is to halt instantly the action of the developer. A number of prepared stop baths are available both in powder and liquid form. However, an inexpensive, effective, and easy-to-prepare stop bath is the acetic-acid type described in Lesson 4. Buy a bottle of *28 percent* acetic-acid solution and prepare your working solution of stop bath by mixing 1½ ounces of the solution with 32 ounces of water. This acetic-acid type of stop bath should be freshly prepared for each darkroom session and then discarded after use.

Note: Be sure you use 28 percent acetic acid in preparing your stop bath. Acetic acid also is available in a stronger [99 percent] solution called *glacial acetic acid.* You can dilute glacial acetic acid to make a working solution of 28 percent by adding three parts of glacial acetic acid to eight parts of water. The glacial acetic solution is a strong acid, and should be handled with care. *Always add acid to water when you're preparing a solution. Never add water to acid, as it may cause a reaction.*

Some of the prepared types of stop baths may be reused until exhausted. In a number, exhaustion is indicated by the color. For example, Kodak Indicator Stop Bath is light yellow when fresh, and looks colorless under a safelight; when exhausted, it turns violet, and appears black under a safelight.

Fixing baths

The purpose of the fixing bath is to neutralize the action of the developer and to dissolve any undeveloped grains of silver, leaving only black metallic silver to form the negative image.

Sodium thiosulfate, called *hypo,* often is the basic ingredient for dissolving undeveloped silver halides. For this reason, hypo has come to be used in a loose generic sense to mean any fixing bath. A typical fixing bath also contains an acid, a preservative, and sometimes a hardening agent to toughen the emulsion of the negative and prevent it from excessive swelling or softening.

A number of prepared fixers are available in powder and liquid form to add to water to make a working solution of fixing bath. Some, but not all, are of the hardening type. Liquid hardeners are available which can be added to certain developers to give them better hardening properties. *In general, it's a good idea to use a hardening fixing bath when developing film.* The toughened emulsion is more resistant to scratching.

One very quick and simple way to make a hardening fixing bath is to completely dissolve 16 ounces of hypo [sodium thiosulfate] in 64 ounces of water, and then add 4 ounces of Kodak Liquid Hardener. This hardener is a concentrated solution available in 1-gallon bottles.

Where speed of processing is necessary or convenient, a *high-speed* or *rapid fixing bath* should be used. These high-speed fixers often use ammonium thiosulfate instead of hypo. Whereas conventional hypo-type fixers usually require about ten minutes to complete their action, the high-speed formulas may require only a couple of minutes or less.

A rough way to check the action of any fixing bath is to drop a scrap end of undeveloped film into it. See how long it takes for the film to "clear"–that is, for the creamy emulsion to be dissolved, leaving only transparent film base. In general, any film you are processing should remain in the hypo for about double the time it takes for the film to "clear."

Most fixing baths can be used either for films or papers. However, the degree of dilution recommended may be different for each use. Be sure to read and follow the manufacturer's directions.

Never use a fixing bath that's nearing exhaustion. "If in doubt, throw it out" is a good motto to follow with any photographic processing solution.

Prepared fixers

Manufacturer and fixer	Available in		Contains hardener	High-speed type
	powder	liquid		
Du Pont				
18-F Universal Fixer	X		X	
Edwal				
Hi-Speed Liquid Fix*		X		X
Quick-Fix		X	X	X
FR				
Fixol		X	X	
Instant Fixol*		X		
Rapid Fixol		X	**	X
Kodak				
Fixer	X		X	
Kodafix Solution		X	X	
Rapid Fix	X		X***	X

*When added to a one-shot developer, it provides modified monobath processing.
**For hardening action, add FR Liquid Hardener.
***Proportion of hardener may be varied as desired.

Time-temperature development tables

In the tables which follow we give suggested exposure indexes [which may differ from the manufacturer's index] and developing time and temperature for various developers for a number of popular black-and-white roll and 35-mm films.

The first table contains information on medium-speed general-purpose films in combination with fine-grain and medium-fine-grain developers; the second table has data on slow, most-sharpness films in combination with compensating developers. Films and developers especially well suited for available-light photography are covered later in this section.

A film and developer from the first table should provide you with a good "workhorse" combination for much of your shooting. A film and developer from the second table is useful when you want maximum sharpness and very fine grain–for architectural shots, close-ups, pictures made for unusually great enlargement, etc. An available-light combination is best when you want highest film speed.

These tables are not exhaustive. You might find you prefer a film and developer not listed. The important thing is that you use a combination that works well for you and that you use it enough to become thoroughly familiar with its performance. Frequent changing of film or developer only leads to confusion and makes it difficult to achieve the confidence and exact control you need for best results.

How to interpret the tables

Next to each film we've given a suggested exposure index. This includes a range–24 to 32, for example, or 200 to 320. The exact exposure index that works best for you is something you'll need to determine by your own tests.

All developing times are given in minutes and are for a temperature of 68 degrees F. unless otherwise indicated. Agitate for 30 seconds at the beginning of development, and then for 10 seconds every minute.

In the table for medium-speed films, a range of developing time is given, such as 9 to 10 minutes, 11 to 13 minutes, etc. Use the shorter time for slightly less contrast, the longer time for slightly more contrast.

These tables are designed for subjects of average contrast. With highly contrasty subjects increase exposure about one half to one stop, and decrease developing time about one third. For very flat subjects, reduce exposure by one half to one stop and increase developing time about one third.

The times given here are for 35-mm and roll film. For sheet film, somewhat longer times should be used, depending on how "heavy" and contrasty a negative you prefer.

Time-temperature development table for medium-speed 35-mm and roll films

Manufacturer and film name	Suggested exposure index	Developer					
		Clayton P-60 [diluted 1:2]	**FR** X-33C [at 70 degrees F.]	**Ilford** Microphen	**Kodak** D-76	**May & Baker** Promicrol	**Plymouth** Ethol UFG [at 70 degrees F.]
		Development time in minutes					
Adox KB21 R21	125-200	9-10	11-13	11-13	9-11	8-10	3-5
Agfa Isopan ISS	125-200	9-10	11-13	11-13	9-11	8-10	3-5
Ilford FP3	160-200	9-11	11-12	9-10	7-8	8-10	
Kodak Plus-X Pan	200-320	7-8	9-11	8-9	7-8 [diluted 1:1]	7-9	3-4
Verichrome Pan	125-200	10-12	17-22	11-13	7 9 [1:1]	–	4 1/2
Perutz Perutz 21	200-320	8-10	16-18	11-13	11-12	9-11	5-6

Time-temperature development table for slow, fine-grain films

Manufacturer and film name	Suggested exposure index	Developer					
		Agfa Rodinal		**FR** X-22		**Plymouth** Ethol TEC [diluted 1:15 at 70 degrees F.]	**Tetenal** Neofin Blue [1 vial of developer in 500cc of water]
		[diluted 1:75]	[diluted 1:100]	[diluted 1:19]	[diluted 1:15]		
		Development time in minutes					
Adox KB14 R14	24-32	–	18	11	–	–	12

Time-temperature development table for slow, fine-grain films [*continued*]

Manufacturer and film name	Suggested exposure index	Developer					
		Agfa Rodinal		**FR** X-22		**Plymouth** Ethol TEC [diluted 1:15 at 70 degrees F.]	**Tetenal** Neofin Blue [1 vial of developer in 500cc of water]
		[diluted 1:75]	[diluted 1:100]	[diluted 1:19]	[diluted 1:15]		
		Development time in minutes					
Adox KB17 R17	50-64	16	–	–	11	9	17
Agfa Isopan IF	100	16	–	–	11	9	18
Isopan IFF	24-32	–	18	10	–	–	14
Ilford Pan F	40-50	16	–	–	10	8	16
Kodak Panatomic-X	40-50	16	–	–	10	8	16

Available-light developing

Available-light photography requires getting the maximum speed possible from your film consistent with good quality. The following film-developer charts have been prepared as a guide to improving your available-light pictures. You'll find the information here particularly helpful for the Home Projects and School Assignments you do for the lessons on indoor lighting, portraiture, press photography, and photojournalism.

Like all film-developer charts, they are starting points only. Variations in equipment and working procedures, and personal taste in the kind of negatives and prints you prefer, may require you to vary the exposure indexes and developing times given here. But they are helpful as a basis for your own testing.

The exposure indexes and developing times in these charts are suggested for use *with subjects having normal contrast.* If you wish to *decrease contrast,* increase your exposure up to a full stop but use the developing times given here. If you want to *increase contrast,* reduce your exposure up to a full stop and increase your developing time about 25 percent.

Note: All developing times are in minutes at a temperature of 68 degrees F. unless otherwise indicated, with 10-second agitation every minute.

Developers and medium-speed films for available light

Here are three medium-speed roll and 35-mm films often used for available-light shooting where the light is fairly bright, and suggested exposure indexes and developing times for several developers. It's generally good practice to use a medium-speed film for this kind of available-light shooting. You can get finer grain and sharper detail this way.

Manufacturer and film name	Suggested exposure index	Developer			
		Ilford Microphen	**Kodak** D-76	**May & Baker** Promicrol	**Plymouth** Ethol UFG [at 70 degrees F.]
		Developing time in minutes			
Ilford FP3	160-200	9-10	7-8	8-10	4-5
Kodak Plus-X Pan	200-320	8-9	7-8 [diluted 1:1]	7-9	3-4
Perutz Perutz 21*	200-320	11-13	11-12	9-11	5-6

*Available in rolls only.

Developers and standard fast films for available light

For shooting in poor available light, or when you want a smaller aperture or faster shutter than a medium-speed film will give you, use a standard high-speed film. The roll and 35-mm films and developers listed here are often used by photojournalists and press photographers in their work.

Manufacturer and film name	Suggested exposure index	Developer			
		Ilford Microphen	**Kodak** D-76	**May & Baker** Promicrol	**Plymouth** Ethol UFG [at 70 degrees F.]
		Developing time in minutes			
Ansco Super Hypan	400-600	10-12	8-10	9-11	4-5
Ilford HP3	400-500	10-12	8-10	9-11	4-5
Kodak Tri-X Pan	400-600	9	8	8	4-5

Developers and super-fast films for available light

You should only use these roll and 35-mm films when you really need the extra speed they provide. They tend to be quite grainy.

Manufacturer and film name	Suggested exposure index	Developer					
		Agfa Rodinal [diluted 1:50]	**Ilford** Microphen	**Kodak** D-76	**Kodak** DK-60a [at 70 degrees F.]	**May & Baker** Promicrol	**Plymouth** Ethol UFG [at 70 degrees F.]
		Developing time in minutes					
Agfa							
Isopan Record	1600-2400	15-20	–	–	–	–	7-9
Ilford							
HPS	800-1000	–	12-14	10-12	–	13-15	5-7
Kodak							
Royal-X Pan*	1600-2400	–	–	–	6-10	–	–

*Available in 35-mm in bulk loads only under the designation Royal-X Pan Recording.

Developing in Acufine

Acufine is a sharp, fine-grain developer that allows you to employ an unusually high exposure index with certain films. It is widely used for available-light 35-mm and roll-film developing. The chart gives suggested exposure indexes and developing times with a number of medium and fast films. In most cases somewhat longer developing time is recommended for the roll film than for the 35-mm version of the film.

Minutes are given in boldface, seconds in regular type. Exact timing is important with this developer.

Film	Suggested exposure index	Developing time at 68 degrees F. [in minutes and seconds]	
		roll	35 mm
Ansco			
Super Hypan	1000	**8**:45	**7**:45

Developing in Acufine [*continued*]

Film	Suggested exposure index	Developing time at 68 degrees F. [in minutes and seconds]	
		roll	35 mm
Ilford			
FP3	250	**6**:35	**3**:45
Kodak			
Plus-X Pan	320	**4**:30	**4**:30
Tri-X	1200	**6**:35	**5**:15

Printing and enlarging

Detailed step-by-step directions for making prints and enlargements are given in your lessons. Here we'll give some additional facts and information about papers for contact printing and enlarging, paper developers, types of enlargers, and other pertinent subjects.

Printing papers

A large number of papers are available to the photographer. Choosing the right paper for your purpose can be an important part of achieving a good, professional quality print. Therefore, it's worth your while to understand the basic ways in which photographic papers may differ. These include *speed, contrast, tone, surface texture, surface sheen, tint* and *weight* of paper stock, and *color sensitivity*. Let's take a brief look at each of these characteristics.

Paper speed

Papers are available in different speeds, just as films are. Speed refers to the paper's sensitivity to light and the amount of exposure required in printing. Some papers are slow and are designed for contact printing, where a relatively bright light can be used to make the exposure. Kodak Velox is a good example of this kind of paper. Papers suitable for enlarging are considerably faster. [They can be used for contact printing, too, if you wish.] Du Pont Velour Black and Kodak Kodabromide are examples. Also available are very fast papers designed to cut exposure time during enlarging to a minimum. Du Pont High-Speed Varigam is a paper of this kind.

If you do mostly contact printing, one of the slow [and less expensive] contact-printing papers is a good choice. However, if you do both enlarging and contact printing, you may prefer to use a fast paper for both purposes to avoid the inconvenience of stocking more than one kind.

Contrast

Contrast, in a photographic printing paper, is a product of two characteristics –*gradient* and *density range*, in technical language. Roughly speaking, density range refers to the difference between the blackest black and the whitest white the paper is capable of producing, and gradient refers to the number of distinct

shades of gray in between these extremes that the paper gives. A low-contrast paper has a long "scale." That is, it can produce a relatively great number of intermediate gray tones from light to dark. A high-contrast paper has a shorter scale–the number of tones will be less between its darkest dark and its lightest light.

If all negatives were perfect and uniform in contrast there would be no need to supply papers in different contrast grades. But different grades are necessary to allow the photographer to find a degree of contrast that gives the best print from a particular negative. With an overly contrasty negative, for example, you probably would get best results if you printed on a low-contrast paper. With a very "flat" [low-contrast] negative, a high-contrast printing paper would probably give you the best print.

Most printing papers [both contact and enlarging types] are available in several grades. Paper grades range from Nos. 0 to 6. The higher the number the greater the contrast and the shorter the scale. Grades No. 0 and No. 1 are considered low-contrast papers, grades No. 2 and No. 3 are normal contrast [they usually print well with a good normal negative], grades No. 4 and No. 5 are high-contrast papers and grade No. 6 is a very high-contrast paper.

Not all graded papers are available in all seven grades, however, nor is it usually necessary to have all grades at hand in your darkroom. Most photographers who print with graded papers have a relatively large supply of No. 2 or No. 3, plus a smaller supply of No. 1 and No. 4. This should serve normal requirements.

Variable-contrast papers: Another method of controlling print contrast is offered by *variable-contrast papers*, such as Ansco VeeCee, Kodak Polycontrast, Du Pont Varigam, and Ilford Multigrade. With these papers you can control contrast by means of colored filters placed between the light source and the paper. This does away with the need for buying and storing a number of different contrast grades, and also offers great flexibility in printing. [For example, you can print a contrasty area of the picture with a filter producing a low-contrast effect, or bring up the contrast in a selected part of the picture with a high-contrast filter.] Filters for use with variable-contrast papers are supplied by the manufacturers. See the data sheet accompanying the paper for details.

Tone

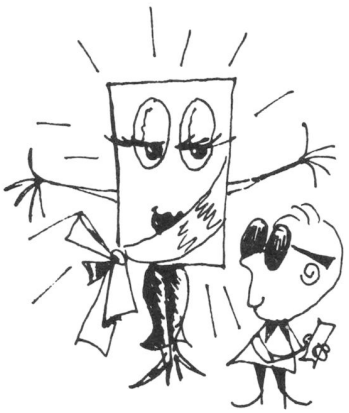
The *tone* [also called *image tone*] of a paper is the color of the converted metallic silver in the finished print. If the paper produces brownish blacks it is said to be *warm toned*. A *neutral-toned* paper has blacks that are neither brown nor blue. If the paper has bluish blacks, it's said to be *cold toned*. The warmth or coldness of papers also can be affected by your choice of printing developer. Some developers emphasize warm tones, others emphasize cold tones.

Choice of tone is largely a matter of personal taste. Many professionals who make prints for commercial or reproduction purposes prefer a neutral or cold-toned paper because they like rich, deep blacks. However, warm-toned papers often are preferred for portraits.

Surface texture

This refers to the texture of the paper's surface–whether smooth or rough. The smoother the surface, the finer the detail that the paper can record. *Smooth*

papers have no noticeable surface texture or pattern. Because of their ability to show fine detail they generally are best for small prints and photographs intended for reproduction. *Fine-grained papers* have a slight surface texture, and are sometimes preferred for display prints, portraits, and landscapes. *Rough papers* have a strongly textured surface and tend to subdue fine detail. Special surfaces, such as *silk* [with a shiny, clothlike texture], *tweed* [very rough], *pebbled*, *stippled*, *tapestry*, and *suede*, also are available. However, for the most part, a smooth or fine-grained paper should serve your purposes best.



Surface sheen

Surface sheen, or luster, is another quality of printing paper you should be aware of. In general, the glossier the paper, the blacker the black you can get–and the greater the possible range of tones.

A *smooth glossy paper* gives you the greatest possible range of tones, and records the finest detail. Therefore, it should be used in prints intended for reproduction and when the rendering of small detail is important. [A smooth glossy paper is suitable for most of the prints you make for assignments in this Course.] Glossy prints sometimes are ferrotyped, as explained in the lesson on professional procedures, but also may be left unferrotyped if you wish. *Semiglossy* paper is similar to glossy paper with slightly less shine.

Luster surfaces have somewhat less sheen than glossy papers and are available in a variety of textures–rough, smooth, fine-grain, tapestry, etc. Luster surfaces are not designed to be ferrotyped. They often are used for display prints and portraits.

Matte and semimatte surfaces are dull and tend to subdue the overall contrast of a print. Their use is usually limited to prints where a special effect is desired.

Tint of paper stock

The *tint* of a printing paper means the color of the paper stock, such as white, cream, and ivory. White is probably best for general use, and is desirable for prints made for reproduction. It's usually the logical choice for cold-toned subjects and when you are using a developer that gives a cold-toned effect. Cream [also called cream white] stock is slightly warmer and may be pleasing for portraits, sunlight scenes, and other subjects where you want a slightly warmer effect. The buff-colored, ivory paper stock adds considerable warmth to a print and generally is used only for special pictorial effects.

Weight of paper

Most printing papers are available in two thicknesses or weights–single weight [relatively thin] and double weight [a thicker, heavier stock]. For small prints the single-weight paper is satisfactory. But for large prints–especially prints that may be sent through the mail or undergo a considerable amount of handling–double-weight paper should be used, because it is less likely to become bent, cracked, or dog-eared. [We require prints made for School Assignments to be on double-weight paper for this reason.]

Color sensitivity

Papers differ in their sensitivity to light of certain colors. A safelight of the proper color must be used to avoid fogging the paper. Be sure to [1] use a safelight of the type recommended by the manufacturer, [2] use a bulb of

recommended wattage, and [3] follow directions regarding the correct working distance of the safelight from your paper. [This information is included with the paper data sheet.]

More and more amateur and professional darkrooms are standardizing on a Wratten Series OC or Du Pont 55-X [light amber] safelight for printing and enlarging. This type of safelight is suitable for the several makes of variable-contrast paper, and also, when properly used, with graded enlarging and contact papers. The Wratten Series OA [yellow-green] type of safelight is safe with graded papers, but should *not* be used with variable-contrast papers. [See the accompanying list for basic safelight recommendations for printing and developing.]

Severe fogging due to an unsafe safelight is easy to discover. The borders of the paper will look gray. More common–and difficult to detect–is the subtle fogging caused by a safelight that's a little too strong or too close. Sometimes the exposure to the safelight alone won't fog the paper, but when this is added to your printing exposure the result may be an overall loss of quality. Highlights may not be as clean and pure white as they should be, and the print may lack sparkle. The following test will help you make sure your safelight will not fog your paper under normal working conditions.

With all lights out in your darkroom, place a sheet of enlarging paper on your enlarger easel and give it a brief exposure with the lens stopped down–just enough to give the paper a light gray tone overall when processed. [You may need to make tests with small scraps of enlarging paper to determine just how much exposure is correct.] Then place a quarter or other coin on top of the paper and expose to illumination from your safelight for five minutes, with the safelight at a normal working distance. Process the print in your usual way. If you can see the outline of the coin, your safelight is not absolutely safe.

Which safelight should you use?

For graded contact and enlarging papers–Wratten Series OA [yellow-green], Wratten Series OC [light amber], or Du Pont 55-X [light amber]

For variable-contrast enlarging papers–Wratten Series OC [light amber] or Du Pont 55-X [light amber]; do *not* use an OA [yellow-green] safelight.

For panchromatic films–Wratten Series 3 [dark green]

For orthochromatic films–Wratten Series 2 [dark red]

Contact papers

Manufacturer and paper	Tone	Single weight	Double weight	Available in these contrast grades	Available in these tints, surfaces, and sheens*
Agfa					
Lupex	neutral	X		1-2-3-4-5-6	*white* glossy
Ansco					
Convira	cold	X	X	1-2-3-4	*white* glossy
Cyko	neutral	X		1-2-3-4	*white* glossy
Lustrex	warm	X	X	0-1-2-3-4	*white* glossy pebbled silk
Kodak					
Aristo	warm		X	1-2-3	*cream white* luster silk *old ivory* luster
Athena	warm		X	0-1-2-3	*cream white* smooth luster fine-grained luster silk
Azo	neutral	X	X	0-1-2-3-4-5-6	*white* glossy smooth luster fine-grained luster *snow white* high luster
Illustrator's Azo	warm	X	X	0-1-2-3-4	*white* glossy fine-grained luster
Velox	cold	X		1-2-3-4	*white* glossy

*All tints, surfaces, and sheens may not be available in *all* contrast grades and weights. Refer to manufacturer's literature for details.

Enlarging papers

Manufacturer and paper	Tone	Single weight	Double weight	Available in these contrast grades	Available in these tints, surfaces, and sheens*
Agfa Brovira	neutral	X	X	1-2-3-4-5-6	*white* glossy semimatte matte silk crystal *cream* semimatte
Portriga Rapid	warm		X	2-3-4	*white* glossy matte fine-grained luster portrait
Ansco Ardura	warm		X	normal only	*white* pebbled stippled silk
Cykora	warm	X	X	1-2-3-4	*white* glossy pebbled stippled silk
Indiatone	warm		X	normal only	*white* smooth rough pebbled stippled silk
Jet	neutral	X	X	1-2-3-4	*white* glossy semimatte pebbled

*All tints, surfaces, and sheens may not be available in *all* contrast grades and weights. Refer to manufacturer's literature for details.

Manufacturer and paper	Tone	Single weight	Double weight	Available in these contrast grades	Available in these tints, surfaces, and sheens*
Du Pont Velour Black	cold	X	X	1-2-3-4	*white* glossy semiglossy velvet-grain high luster velvet-grain luster semimatte silk
Warmtone	warm		X	normal only	*white* velvet-grain luster velvet-grain high luster rough luster silk rough cloth
Kodak Kodabromide	neutral	X	X	1-2-3-4-5	*white* glossy smooth luster fine-grained luster *cream white* smooth luster
Medalist	warm	X	X	1-2-3-4	*white* glossy luster high luster *cream white* luster silk
Opal	warm		X	normal only	*cream white* smooth luster fine-grained luster rough luster matte tweed suede silk *old ivory* fine-grained luster tapestry luster

*All tints, surfaces, and sheens may not be available in *all* contrast grades and weights. Refer to manufacturer's literature for details.

Variable-contrast enlarging papers

Manufacturer and paper	Tone	Single weight	Double weight	Available in these tints, surfaces, and sheens*
Ansco VeeCee	warm	X		*white* glossy
Du Pont High-Speed Varigam	cold	X	X	*white* glossy semiglossy semimatte velvet-grain luster
Varigam	cold	X	X	*white* glossy semiglossy semimatte velvet-grain luster velvet-grain high luster silk
Varilour	warm	X	X	*white* glossy velvet-grain luster semimatte silk *brilliant white* glossy
Ilford Multigrade	neutral	X	X	*white* glossy stippled
Kodak Polycontrast	warm	X	X	*white* glossy smooth luster *cream white* fine-grained luster
Polycontrast Rapid	warm	X	X	*white* glossy smooth luster *cream white* fine-grained luster silk

*All tints, surfaces, and sheens may not be available in *all* contrast grades and weights. Refer to manufacturer's literature for details.

Variable-contrast enlarging papers [*continued*]

Manufacturer and paper	Tone	Single weight	Double weight	Available in these tints, surfaces, and sheens*
Kodak				*white*
Polylure	warm	X	X	glossy *cream white* fine-grained luster tweed silk

*All tints, surfaces, and sheens may not be available in *all* contrast grades and weights. Refer to manufacturer's literature for details.

Paper developers for contact prints and enlargements

A number of developers are available designed only or primarily for use with contact prints and enlargements. As with film developers, some are in powder form and some in liquid. Choice of paper developer is largely a matter of taste. Some tend to produce cold tones [blue-blacks] and others to produce warm tones [brownish blacks] when used with certain papers. This effect on tonality is usually rather subtle, and it may vary depending on the particular paper used with the developer. The combination that gives the effect you like best is something you'll need to determine by experimenting. In general, however, if you like tones on the cold side, combine a neutral or cold-toned paper and a cold-toned developer; if you prefer warmer tones [as in portraits, for example] combine a warm-toned paper and a warm-toned developer.

Do not run more prints through a batch of developer than the maximum amount the developer manufacturer recommends. Discard your working solution of paper developer at the end of your printing session.

The following chart lists some popular, generally available paper developers.

Paper developers

Manufacturer and developer	Tone		Available in	
	cold	warm	powder	liquid
Agfa				
Neutol		X	X	
Ansco				
Ardol		X	X	
Vividol	X		X	

Paper developers [*continued*]

Manufacturer and developer	Tone		Available in	
	cold	warm	powder	liquid
Du Pont				
55-D		X	X	
Edwal				
Platinum Concentrate	X			X
FR				
Paper Developer	X			X
Kodak				
Dektol	X		X	
Selectol		X	X	
Selectol Soft		X	X	
Plymouth				
Ethol LPD*			X	

*Designed to produce cold tones with cold-toned papers and warm tones with warm-toned papers.

Enlargers

An enlarger is a key link in the chain of equipment and processes that leads from exposure to a good print. Here are a few basic facts to keep in mind when choosing or working with an enlarger.

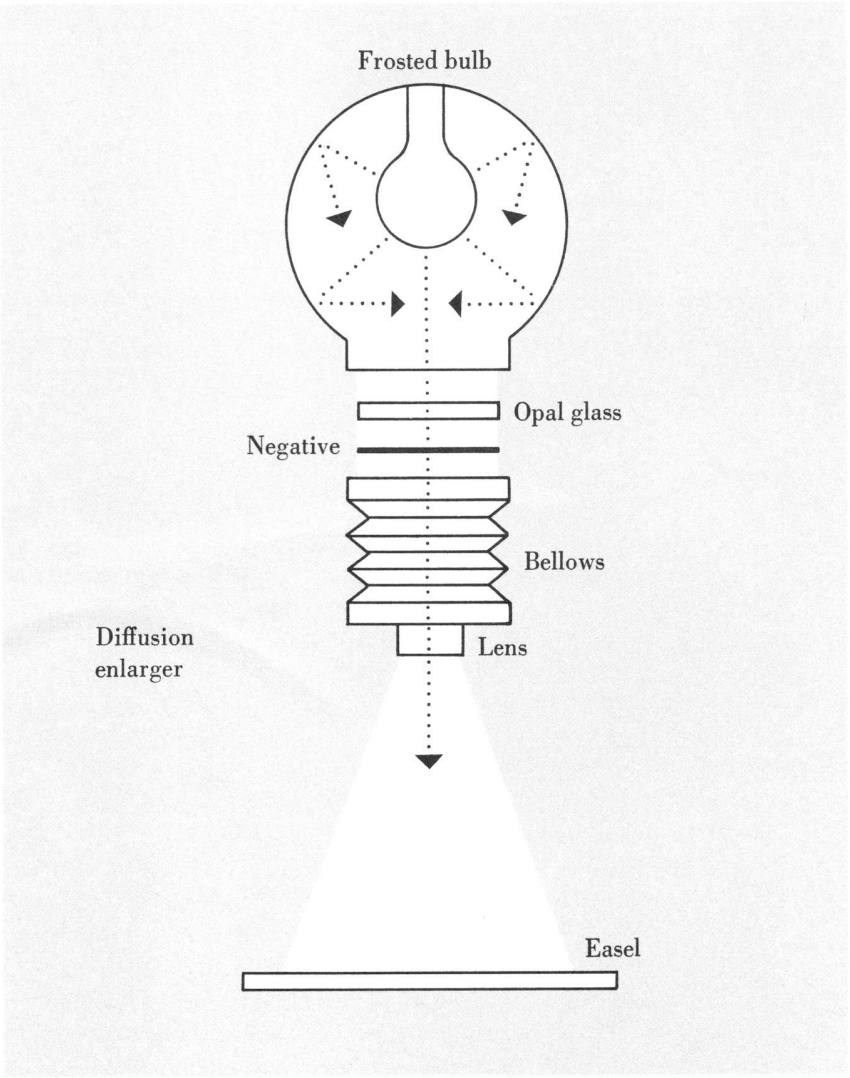
Enlargers are classified according to the lighting system they use–*diffusion*, *condenser*, or *cold light*. Each type of lighting system tends to produce different effects, as we'll explain.

Diffusion enlarger

With the diffusion enlarger, a frosted bulb in the enlarger head provides the illumination. This light is reflected off the white painted surface inside the enlarger head. It is further diffused by passing through a sheet of translucent opal glass located between the light source and the negative.

This type of enlarger tends to project a relatively low-contrast image. Therefore, if you use a diffusion enlarger, you may find you need to expose and develop to get negatives that are somewhat more contrasty than are required for a condenser-type enlarger.

You may also find that you need to use a higher contrast grade of paper. For example, a negative that gives a normal print on a No. 2 paper with a condenser-type enlarger may require a No. 3 paper with a diffusion enlarger to get an equal degree of contrast.

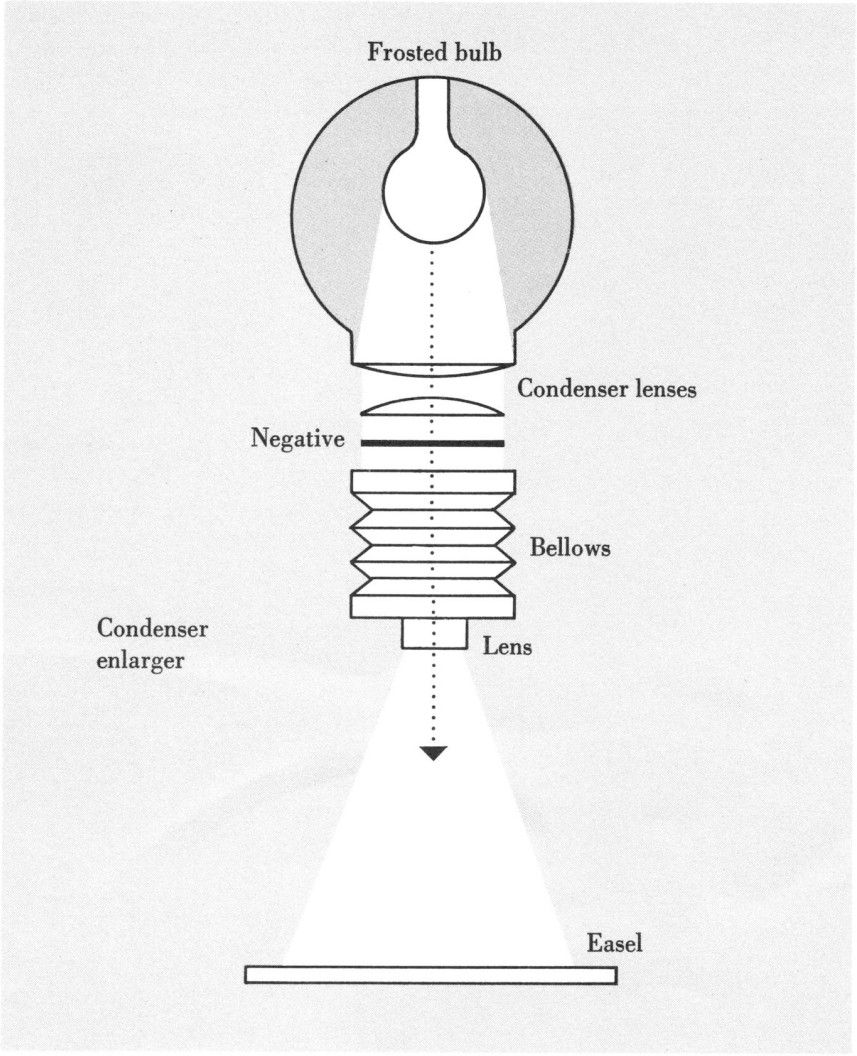


An advantage of a diffusion enlarger is that it tends to minimize any scratches or dust. Also, its low-contrast effect may be helpful when you're printing an overly contrasty negative.

The relatively dim, diffused light of this type of enlarger requires long printing exposure times, and also may make very precise focusing a little more difficult.

Condenser enlarger

A condenser enlarger also uses a frosted bulb as the basic light source, but instead of diffusing the light, it concentrates it by one or more condenser lenses placed between the light source and the negative.



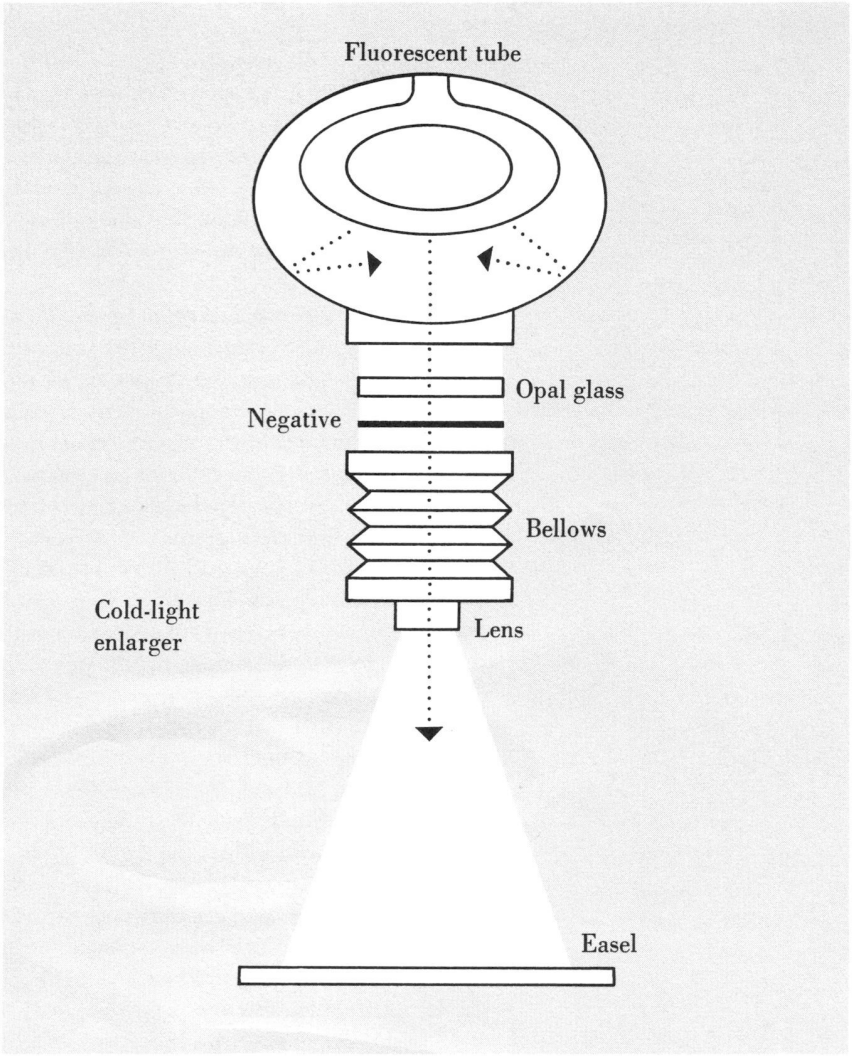
The intense, concentrated light of a condenser enlarger produces a brighter, more contrasty image than does a diffusion enlarger. Therefore, a somewhat thinner, less contrasty negative usually produces the best results with this kind of equipment. Critical focusing is easier to accomplish, and printing exposure times are relatively short with a condenser enlarger. It enables you get the most contrast–an advantage with flat negatives.

This type of lighting system does have a disadvantage, however. Its sharp, contrasty light tends to emphasize any scratches, dust, or other imperfections in your negative. If you're working with a condenser enlarger you'll have to be particularly careful to avoid these flaws.

Cold-light enlarger

A cold-light enlarger uses a fluorescent tube to produce the light. An advantage to this kind of enlarger is that it doesn't get as hot during operation as the diffusion and condenser types do. [A hot enlarger can be uncomfortable for the person running it, and may cause negatives to curl or even endanger them if the heat becomes too great.]

Cold-light enlargers produce a relatively soft, dim, bluish white light. As with the diffusion enlarger, a more contrasty negative usually is required for



normal results. Printing papers are particularly sensitive to bluish light, so exposure times are not as long as might be expected considering the relatively dim image produced by a cold-light enlarger. Also, dust and scratches tend to be minimized.

If you use a variable-contrast paper and filters with a cold-light enlarger, the contrast effect of the various filters will be different from the effect they give with a diffusion or condenser enlarger. You won't be able to get as high a degree of contrast out of variable-contrast papers. Therefore, you'll need to determine the effect of different filters by experimenting.

The cold-light enlarger's fluorescent tube tends to increase in brightness after it's turned on. On some models it may take at least a minute for the light to reach its maximum brightness and level off. This can make it difficult to control exposure accurately. The usual procedure is to *leave the light burning during the entire printing session.* Exposure can be controlled by a red filter. When the filter is placed under the enlarger lens, the light won't affect the printing paper. To make an exposure, remove the red filter for the desired length of time. [Most enlargers are equipped with a swinging arm that will hold a filter in place under the enlarger lens.] Another solution is to equip your enlarger with an electrically controlled shutter connected to your timer. The timer opens the shutter to make an exposure, then closes it.

Developing your black-and-white film

We urge you to do your own black-and-white darkroom work–developing film and making contact prints and enlargements–at least for the duration of your Course. We feel that you won't get the most benefit from the Course, nor become a well-rounded photographer, without having acquired the basic skills of this aspect of photography. Even if later on you should decide to have your processing done by a photo lab, you will need the knowledge which can only be obtained in the darkroom in order to give directions properly and to evaluate the results.

By doing your own darkroom work, you can save considerable money over the cost of having the work done for you. But even more important, your *darkroom work helps you become a better photographer.* It can sharpen your seeing and give you a deeper understanding of the photographic process–of what your film and camera can and cannot record. It can increase your skill in judging the lighting and contrast in a scene, in controlling exposure, in selecting the most effective lighting for your purpose. Even if you are primarily interested in color photography, experience with black-and-white can markedly improve your skill with color, as many of our students have discovered. Finally, by developing your own film and making your own prints and enlargements, you control every step of the process. You can more readily impress your own personality on your pictures, and produce prints that truly reveal your taste, creative judgement, and interpretation of the subject.

We suggest that you start early in the Course to acquire the necessary equipment and chemicals you need for black-and-white film developing. The items required for time-temperature developing in a daylight tank [the method we teach in Lesson 4] are few and relatively inexpensive. You don't require a darkroom, either. Except for loading the film into the tank, all remaining steps can be done by ordinary room light.

The items you'll need are shown on page 28 of Lesson 4. Following is some additional information to help you select the most useful equipment. The advice of a good photo dealer can be very valuable, too. He can demonstrate different makes of equipment for you, help you choose the type that best fits your needs and budget, and answer specific questions.

Equipment you need

A daylight developing tank

The all-metal stainless-steel type, such as made by Nikkor, is the most expensive, but the most durable. Many professionals use this type of tank. It is relatively easy to clean and load and, because metal is a good conductor of heat, enables you to control the temperature of your solutions more easily than is the case with a plastic tank.

Less expensive, but also serviceable, is the plastic type of developing tank. Treated with reasonable care, it will last indefinitely.

If you plan to use both 35-mm and roll film, make provision for this when you buy your tank. Both plastic and metal tanks are available in adjustable models with a reel designed to hold film of various sizes. With an all-metal tank, you also can get separate reels for 35-mm and 120 size films, and use them interchangeably in the same tank.
Price range, about $2.50 to $13.00.

Darkroom thermometer

Get an accurate, good-quality one–of the type that dips into the tank. It should have a large, easy-to-read scale. An accurate thermometer is important because in black-and-white photography you often are required to control the developer temperature within 2 degrees of a recommended temperature.
Price, about $1.50 to $2.00.

Mixing graduate

To mix your solutions, use a one-quart glass or enamel mixing graduate marked in liquid ounces. We recommend the enamel, hospital type shown in Lesson 4, page 28. This type is unbreakable and, because metal conducts heat well, you can more easily control the temperature of your solutions. By placing the graduate holding the warm, freshly mixed solution in a container of cold water, you can fairly quickly bring the temperature down to working level. With a glass graduate, this usually takes longer. One graduate should do for a start; you'll probably want to add more later.
Price, about $2.00.

Film clips

These are metal clips you attach to a strip of developed film so that you can hang it for drying. Get the weighted type, which holds the film straight and prevents it from curling while drying. You need at least one pair.
Price, about 50 cents to $1.00 a pair.

Sponges

You should have a pair of fine-textured cellulose photographic sponges for wiping the film dry. Be sure to use only sponges especially designed for photographic purposes–other types may be too coarse and tend to scratch the film emulsion. [Some photographers prefer to use a wetting agent such as Photo-Flo and omit drying the film with a sponge; others do both, or omit the wetting agent and only wipe the film dry.] At the first sign of shredding throw away the sponge and replace it with a fresh one.
Price, about $1.00 a pair.

Bottles

You should have at least four one-quart bottles to hold your various solutions, and you'll no doubt want more as time goes on. We recommend the wide-mouthed, amber glass or plastic type of bottle. *Be sure to label the contents clearly.*
Price, about 85 cents per bottle.

Darkroom timer

You can use a watch with a sweep second hand, or a kitchen timer, but a timer specifically designed for darkroom purposes is more convenient. You set the dial for a specified time. At the end of that time an alarm sounds.
Price, about $6.00 and up.

Darkroom tray

A tray is not absolutely necessary for tank developing of film, but it is useful to hold your tanks and bottles of solution so that you don't accidentally spill chemical solutions on the floor or tabletop. You'll need trays anyway, for Lesson 5, so you might as well get at least one now.

Trays are available in stainless steel, enamel, hard rubber, and plastic. Stainless steel trays are the most expensive and durable, but the cost probably is not justified unless you are putting them to heavy professional use. Enamel trays are standard in many darkrooms, but after a time they do tend to chip and stain. Hard rubber trays don't chip, but some photographers feel they are more difficult to keep clean. Plastic trays are inexpensive, but perfectly adequate if you are careful not to crack them or expose them to excessive heat.

Your trays should be larger than the maximum size print you normally make so that you can submerge the print quickly and evenly. Since you will be required to make 8x10 enlargements for this Course, we suggest you get 11x14 trays.

Price, about $2.00 and up for 8x10 size, about $4.50 and up for 11x14 size.

Additional items

You will also need a *plastic or glass stirring rod* for mixing the chemicals and a *small glass or plastic funnel* for pouring solutions without spilling.

Price, about 25 cents for the rod and 50 cents for the funnel.

Photographic chemicals you need

The necessary chemicals for black-and-white developing include [1] developer, [2] stop bath, [3] fixing bath, and [4] wetting agent [optional]. For details, see the discussion and demonstration on pages 27-31 of Lesson 4 in your textbook, and pages 73-89 of your Technical Manual.

A large number of film-developer combinations will yield excellent results. If you are just beginning in photography, however, we recommend that for the majority of your shooting in early lessons you standardize on a medium-speed film, such as Kodak Plus-X Pan, Ilford FP3, Adox KB21 or R21, or Agfa Isopan ISS, and a standard fine-grain developer such as Ansco Finex-L, Edwal Super 12, FR X-33C, Kodak Microdol-X, Ethol UFG and Acufine. Properly used, combinations like these give you considerable exposure latitude, enough speed for all but poor available-light shooting, and fine-grain negatives.

Some photographers prefer to omit the stop bath, using a plain water rinse instead, because they find that the sudden plunge into an acid stop bath may cause gas to form in the film emulsion, resulting in "pin pricks." However, a stop bath enables you to halt the action of the developer at precisely the moment you wish–an advantage when using a developer whose developing time is measured in a few minutes, as is the case with a number of popular modern formulas. Also, the use of a stop bath to neutralize your developer will tend to prolong the life of your fixing bath. Therefore, we recommend you use a stop bath for film developing unless it seems to cause pin pricks. You can very inexpensively make a stop bath from acetic acid as described on page 82 of the Technical Manual, or use a prepared stop bath such as Kodak Indicator Stop Bath.

An ordinary fixing bath of sodium thiosulfate ["hypo"] plus hardener is inexpensive and satisfactory. However, many photographers find it more convenient to use a high-speed fixer such as Edwal Hi-Speed Liquid Fix, FR Rapid Fixol, or Kodak Rapid Fix because this shortens fixing time from about 10 minutes to about three minutes. We recommend you use a hardening-type fixing bath–the hardener toughens the film emulsion and reduces the danger of scratches, thumb prints, etc.

Many photographers today use a *hypo-eliminator* after the fixing bath. Hypo-eliminator reduces the amount of washing the film needs, thus saving you time and water, and helping to insure the permanence of the image.

How to choose an enlarger

For the serious photographer–amateur or professional–a good enlarger is second in importance only to a good camera. If you don't already own an enlarger, we urge you to get and learn to use one as early as possible.

It's a sensible idea, before buying an enlarger, to gain some experience actually making enlargements–perhaps with the equipment of a friend or the facilities of a camera club darkroom. After going through the procedure a few times you'll be much better qualified to make an intelligent decision about which characteristics and features you want.

The best way to buy an enlarger is through a reputable dealer, who will demonstrate the equipment, answer your questions, give you specific guidance –and back up the product with a guarantee.

In purchasing an enlarger and lens, get the highest quality you can afford. A high-quality enlarger will provide you with many years of fine service. A poorly constructed one can be a source of frustration, and prevent you from achieving the best possible results from your negatives.

If cost is an important consideration, we suggest you explore the possibility of buying a used enlarger. Often you can find excellent buys in used equipment in camera stores or through private individuals. [Look in the classified section of your local newspaper for listings.]

Enlarger size

Enlargers are available in a number of sizes, ranging from those designed especially for tiny subminiature negatives up to very large professional models that handle 8x10. Among amateur photographers, enlargers for 35-mm and 2 1/4 x 2 1/4 [or 2 1/4 x 3 1/4] roll-film negatives are especially popular. For professionals, enlargers handling up to 4x5 negatives generally are considered standard equipment. Many enlargers accept different-size negatives up to the maximum for which the enlarger is designed.

Which is the best size for you? One that serves your needs now, of course. But we also recommend you get an enlarger that allows for possible changes in, or additions to, your camera equipment in the future.

For example, if you shoot only 35-mm and 2 1/4 x 2 1/4 roll-film now, then an enlarger that accepts up to 2 1/4 x 2 1/4 will take care of your present needs. But suppose you anticipate buying a 4x5 camera later on, for architectural or studio work, let us say. In that case you might be wise to buy an enlarger now that handles up to 4x5, thus avoiding the need to replace your enlarger or acquire a new one when you start using 4x5.

With most enlargers you require a different negative holder for each size negative you want to enlarge. [With a few models the negative holder has variable borders so it can accept more than one size of negative.] With condenser enlargers you also may require a different set of condensers for best results with each film format. However, at least one model now is equipped with variable condensers, and some other types use supplementary condensers, so that you aren't required to replace the complete set of condensers each time you change to another film format.

Also, we recommend that you acquire a lens of the correct focal length for each size negative you customarily enlarge. The focal length of the enlarging lens should be approximately the same as the length of the normal taking lens

for the camera: for example, a lens of approximately 50 mm for a 35-mm negative, a lens of about 75-90 mm for 2 1/4 x 2 1/4 or 2 1/4 x 3 1/4 negatives, and a 135-mm or 150-mm lens for 4 x 5 negatives.

Your enlarging lens should be of comparable quality to your camera lens, because a poor lens on your enlarger won't be able to reproduce the detail recorded by a fine camera lens. It may be possible, depending on your equipment, to use your camera lens on your enlarger. However, most photographers find they get more satisfactory performance by using a lens especially designed for enlarging.

Naturally, at the beginning you don't have to acquire all the enlarging lenses, condensers, and negative holders needed to cover every contingency. For instance, you might decide to buy a 4 x 5 enlarger, but equip it only with a 35-mm negative holder and a 50-mm lens for the time being [assuming no other condenser is needed with this model]. Later, if you acquire larger camera equipment, you can add the necessary accessories to accommodate the larger film size.

Enlarger types

In terms of the lighting system used, the three basic types of enlargers are diffusion, condenser, and cold light. Which type is best for you is largely a matter of personal taste and individual working methods. See pages 98-101 of the Technical Manual for diagrams illustrating the three types and a discussion of the pros and cons.

Some points to look for when buying an enlarger

Rigid construction is important in any enlarger. If the enlarger is flimsy or shaky it will tend to vibrate during the printing exposure and impair the sharpness of your pictures–especially when the enlarger head is run all the way to the top of the column. Also check the baseboard to be sure it isn't warped–this can cause the enlarger to rock, and thus blur the enlargement.

How big is the enlarger, and [very important] how tall is it? Will it fit into the darkroom area and storage space you have available for it?

Do all the controls and moving parts work smoothly? Do the locking knobs hold the head securely in place, with no looseness or slippage? Work the focusing control to test its action, and run the enlarger head up and down the column to check for any roughness or tendency to stick.

Are all switches and electrical connections in good working condition?

Are there any leaks in the enlarger's bellows? You can test this by capping the lens, turning the enlarger lamp on, extending the bellows, and then examining it for pinholes, cracks, or other light leaks.

When the enlarger head is fully raised, does the projected image cover the baseboard without interference from the column or other parts of the enlarger?

If you want to make very big enlargements, can you tilt and/or swing the enlarger head to project onto the wall or floor?

A word about negative holders

A glass negative holder will keep your negative perfectly flat, and therefore is preferred by some photographers. However, this type of holder is extremely difficult to keep free of dust, fingerprints, and dirt. Because of this, many photographers prefer the glassless type, and we believe the chances are you will, too. Later on, if you do very critical work, and after you have acquired more experience, you may choose to use the glass type.

Interested in color printing, too?

If you want to make color enlargements now or in the future, read the comments under "Enlarger" on page 156 of your Technical Manual.

What about subminiature negatives?

Special enlargers are available for enlarging subminiature negatives. However, just about any regular enlarger can be adapted for this purpose, if accessory lenses and condensers are purchased. A particularly useful device along this line is Mamiya's Enlahead. It consists of a unit containing a 25-mm enlarging lens, a negative stage with holder, and a condenser. The unit is equipped with Leica-mount threads and is designed to be attached to the regular lens board of most enlargers.

Recommended: a magnifying focusing aid

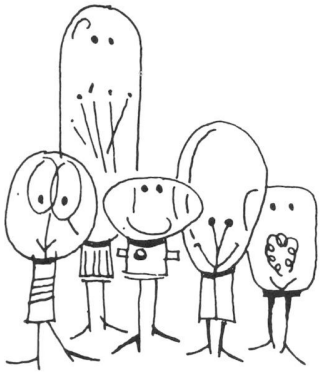
You may feel confident that you can focus sharply by unaided eye alone, but the experience of many amateurs and professionals has demonstrated that most of us aren't as sharp-eyed as we think. To get the sharpest possible results from your negatives and enlarger, we strongly recommend that you purchase a magnifying focusing aid and use it regularly. Some popular makes include the Accura Focusing Aid, the Bausch and Lomb Enlarging Focusing Magnifier, and the Scoponet.

Pointers to remember when using your magnifying aid: [1] Use a blank "target" sheet of enlarging paper in your easel for focusing. [2] Focus with your enlarger lens wide open. [3] When focusing, turn off all darkroom lights, including the safelight, so you will get the brightest possible image. [4] Using your focusing aid, *focus on the grain pattern of the negative.* If the grain itself is in sharp focus, that's as sharp as you can get.

8

Flash and flood

Throughout your Course we demonstrate many ways to use flash and flood to create the lighting effects you want. In this section of your Technical Manual we'll give some basic facts, charts, and guides that will help you choose your lighting equipment and solve some of the practical problems you may encounter. The section is devoted primarily to the more complex subject of flash–conventional and electronic. At the end of the section is reference material on floods, spots, and other incandescent sources of studio lighting.



Flashbulbs

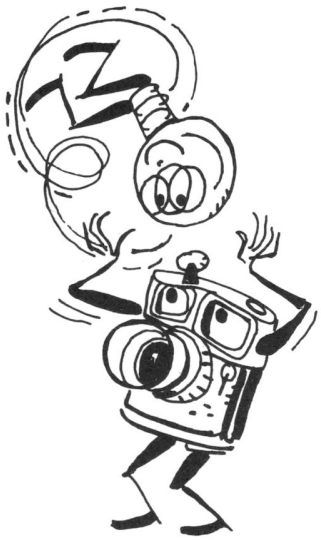
Flashbulbs come in many types, shapes, and sizes designed for many purposes. Your camera's instruction manual is your best guide in selecting the right flashbulbs for your camera. However, the following discussion of flashbulb characteristics and a table of commonly used flashbulbs will give you an overall picture of what's available and can help you choose the right flashbulb for your purpose.

Flash synchronization

In your lesson on indoor lighting, we explained that a flashbulb contains a fine wire filament through which electric current is passed, making the wire white hot. This lights a "primer" powder coated on the tips of the wires supporting the filament. The burning primer, in turn, ignites the combustible material inside the flashbulb–this material usually being an aluminum or zirconium alloy in the form of wire or foil.

When you see a flashbulb go off, all this seems to take place instantaneously. However, that's not the case. Just as in lighting any fire, it takes a time for the wire filament to heat and ignite the primer, and for the primer to set off the

wire or foil. The wire or foil starts to burn with a low flame, flares up as the fire spreads, and then dies down after the combustible material is consumed. The total time is brief–it's measured in *milliseconds*. [One millisecond is 1/1,000 of a second.] But that time lapse is important, as we shall see.

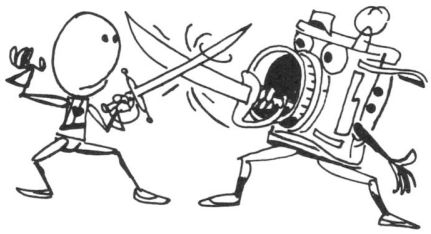


The time it takes for the flame inside the flashbulb to burn at its brightest is known as the *time to peak*. This time to peak varies with different types of flashbulbs. We'll describe these types shortly. *What is important, from a picture-taking standpoint, is that the camera's shutter should be wide open at the time the flashbulb reaches its peak.* Otherwise, some or most of the flashbulb's light may be wasted, and the picture will be underexposed.

It not only takes a flashbulb a certain time to reach its peak, it also takes a shutter a certain amount of time to open. In general, for a blade-type shutter, this is about five milliseconds–a *shorter* time than it takes for most types of flashbulbs to peak. A *flash synchronizer* is a timing device which precisely delays the opening of the shutter long enough to allow the flashbulb to reach its point of brightest burning. Without this delay, at higher shutter speeds, the shutter would have opened and closed before the flashbulb had a chance to reach its peak, and light would be wasted. On most modern cameras, the flash synchronizer is built into the camera's shutter. On some older models, a separate flash synchronizer may need to be fitted to the camera's shutter.

There are four basic types of flash synchronization: **M** [medium delay], **F** [fast or short delay], **X** [instantaneous or no delay; used primarily with electronic flash], and **FP** [for use with a focal-plane shutter and special bulbs, as explained below]. Some cameras are equipped with synchronizers that allow a choice of settings; others offer only one setting, usually F or X.

Flashbulbs for cameras with blade-type shutters



Blade-type shutters [such as those made by Compur, Seikosha, Citizen, Ropax, Graphex, Copal, Prontor, Supermatic, etc.] are found on many types and sizes of cameras. Flashbulbs primarily designed for use with a blade-type shutter generally reach their peak in about 15 to 20 milliseconds. Flashbulbs in this group include the AG1, AG1B, M3, M3B, M5, M5B, 5, 5B, 25, 25B, 11, 40, 22, and 22B. With one of these flashbulbs, a blade-type shutter, and M synchronization, *you can shoot at any marked shutter speed from one second to 1/500 second.* If your camera has a shutter providing only an X or an F setting, you can generally use these bulbs at shutter speeds of up to 1/30 second [in some cases, 1/60 second], but not faster, since they do not reach their peak soon enough to work efficiently with the higher shutter speeds.

Certain flashbulbs such as the M2 and M25 are a special case. These are similar in appearance to the M5 flashbulbs. However, they are designed for use with inexpensive "box" cameras having simple shutter mechanisms. You can also use them with a more advanced blade-type shutter at speeds of 1/30 second or slower and an F or X setting.

Flashbulbs for cameras with focal-plane shutters

Focal-plane shutters are most commonly found on advanced 35-mm cameras with interchangeable lenses and on some press cameras. It takes the slit of a focal-plane shutter a certain time to travel across the negative. For this reason, long-burning "focal-plane" flashbulbs are made especially for use with this

kind of shutter. [The relatively short peak typical of bulbs made to be used with a blade-type shutter would result in an unevenly exposed picture.] The flash setting to use with focal-plane flashbulbs may be marked either FP or M. Check your camera's instruction manual for details.

Very compact "peanut" flashbulbs for focal-plane shutters include Nos. 6, 6B, 26, and 26B. They are intended for use with 35-mm, 2 1/4 x 2 1/4 reflex, and 2 1/4 x 3 1/4 press cameras having focal-plane shutters. Larger flashbulbs for focal-plane shutters include Nos. 2A and 31; these are designed for use with larger cameras, such as 3 1/4 x 4 1/4, or 4x5 press cameras. They have peaks of longer duration than their smaller brothers because the traveling time of the focal-plane slit on larger cameras generally is longer.

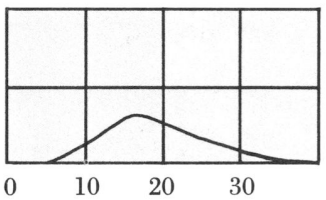
Certain of the newer flashbulbs such as the AG1, AG1B, M5, and M5B, which are primarily designed for use with blade-type shutters, have long enough peaks to permit synchronization with some modern 35-mm focal-plane shutters. However, before relying on these bulbs for any important pictures, run a test first, to be sure you're getting even illumination across the entire negative.

Special slow-peaking flashbulbs

There also are large, powerful flashbulbs such as Nos. 3, 3B, 50, and 50B, which take about 30 milliseconds to reach their peak. They can be synchronized with blade-type shutters at speeds of 1/30 second or slower. However, they are more generally used for "open-flash" shooting. That is, the shutter is opened, the bulb is fired, and then the shutter is closed. This makes full use of all the bulb's output of light. These slow-peaking bulbs can be fired on 110-volt current, and therefore are convenient for use in multiple-flash hookups–especially where considerable length of line may be required. [The current provided by a battery may not be strong enough to work reliably under these conditions.] The open-flash technique often is used in shooting large areas, such as banquet halls and industrial interiors, or large groups of people.

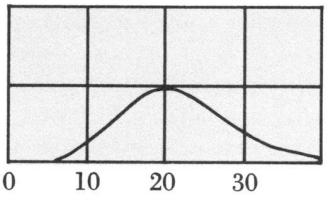
How different flashbulbs reach their peak

The following graphs show how long it takes for four different types of flashbulbs to reach peak burning intensity, and the duration of this peak. Time is measured in milliseconds along the base of the graph. Light output is measured along the vertical dimension. The higher the curve at any given point in time, the more light the bulb is giving at that instant. The AG1, M5, and 5 are designed primarily for use with blade-type shutters and M synchronization; No. 6 is a bulb for use with focal-plane shutters.

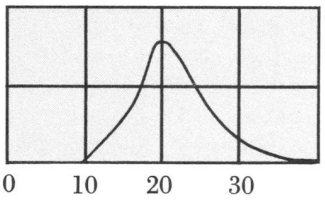


An AG1 peaks [reaches its most intense point of burning] in about 15 milliseconds, and burns brightly for a relatively long time.

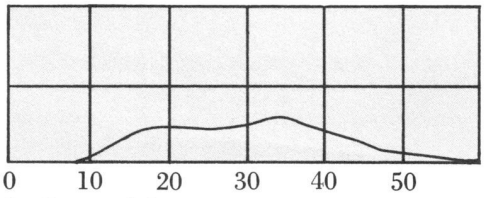
How different flashbulbs reach their peak [*continued*]



An M5 peaks at 20 milliseconds, then subsides quickly.



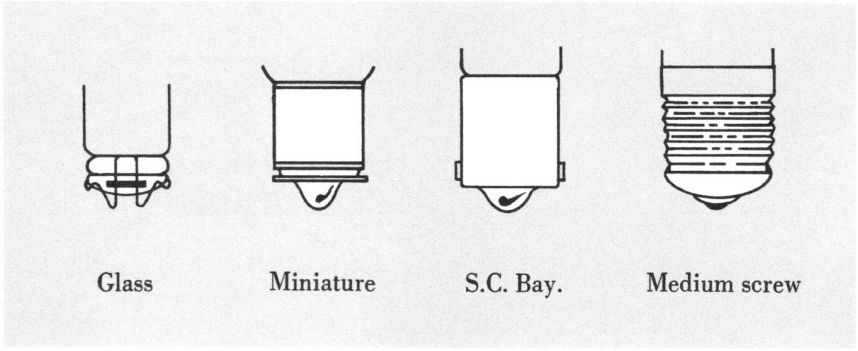
A No. 5 bulb also reaches peak at 20 milliseconds, but has an even steeper rise and fall than the M5.

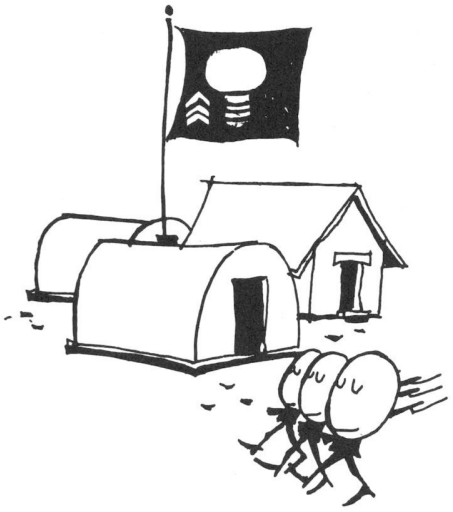


A No. 6 flashbulb has a relatively long, low peak. It's designed for use with focal-plane shutters. The long burning time is planned to give even exposure as the slit in the focal-plane shutter travels across the film.

Flashbulb bases

Flashbulbs are available in different sizes and with different types of bases. [The flashbulb's base is the lower portion that fits into the socket of the flashgun.] In general, the flash reflector that comes with your flash unit is designed to hold a flashbulb with one particular type of base, and to give most efficient results with flashbulbs of this design only. However, in some cases you can buy socket adapters that let you use bulbs with a smaller base than the size for which the socket is designed. Unless there is good reason for doing so, we





suggest you avoid this practice because it may lead to a less efficient use of the bulb's light output.

In the United States, four different types of flashbulb bases are in common use.

1 Glass: This type of base [sometimes called *baseless*] is found on the very tiny "subminiature" flashbulbs such as the AG1. A bulb of this design has no metal base at all. The connection between the flashbulb and the flash unit's electrical supply is made by two lead-in wires that stick out from the glass base. These bulbs are primarily made for use in very small flash units–those with two-inch reflectors–and are helpful where compactness is important.

2 Miniature, no pin: This type of base is found on miniature flashbulbs such as the M2, M3, M5, and M25. Because there is no pin protruding from the base [as with the bayonet-base bulbs described below], you don't need to twist the bulb to the right position when you put it into the socket. A spring action of a collar on a groove around the base of the bulb holds it in place in the flash socket. These bulbs are made to be used with three- to six-inch reflectors. Although small, these bulbs are very efficient in a properly designed reflector, and are widely used in general flash photography.

3 Single-contact bayonet: This type of base sometimes is referred to by the abbreviated form *S. C. Bay.* A pin in the metal base is used to position the bulb and lock it in place in the flash socket. It is found on "peanut" bulbs such as Nos. 5, 6, 25, and 26. These bulbs are designed for four- to six-inch reflectors, and are suitable for general-purpose flash photography.

4 Medium screw: This type of metal base [also called *Medium* or *Med.* for short] is the same as that on most ordinary household electric light bulbs. The base is threaded and must be screwed into the socket. It is found on the larger types of flashbulbs such as Nos. 2, 3, 11, 22, 31, 40, and 50. These bulbs generally are used in professional units with a six- to seven-inch or larger reflector, when a very large quantity of light is needed. Because they fit into ordinary bulb sockets, they can be used interchangeably in reflectors for photoflood bulbs.

Some of these metal-base bulbs, *but not all,* can be fired by 110-volt household current, and thus are useful for multiple-flash hookups and situations that require long lines for firing flashbulbs at a considerable distance from the camera. Only Nos. 2, 2B, 3, 3B, 22, 22B, 50, and 50B bulbs can be used in this way. *If you use any other type of flashbulb on an electrical circuit, the lead-in wires may fuse and cause a short circuit.*

Never connect a 110-volt line to your flashgun.

Severe injury may result.

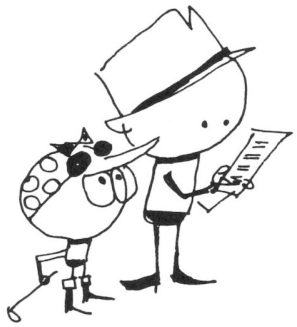
Also, never fire any flashbulb by 220-volt current. In an industrial plant, where 220 volts may often be found, be sure to check with a plant electrician to find out the voltage supplied by any outlets you plan to use.

Flashbulb colors–white, blue, and infrared

The most common type of flashbulb is made of clear glass, and is filled with foil or wire. It gives white light of about 3800K–somewhat cooler [more bluish] than the white light given by a photoflood. This is the type of bulb you normally would choose for black-and-white shooting.

To use them with a *Type A* or *Type B color-transparency film*, you need a warming filter. If you use them with these films without a filter, the colors in your photographs will be too bluish. For Kodak Type A and Type B color films, use an 81C filter or its equivalent. For Anscochrome Type B and Agfachrome CK20 films, use an 81D filter or its equivalent. [See the section on filters for color photography for a detailed discussion and charts.]

If you want to use white flashbulbs with a *daylight type color-transparency film*, for indoor shooting you need a bluish, cooling filter, such as the 80C, 80D, or their equivalent. Use this combination only when flashbulbs are your sole source of illumination. Do *not* attempt to mix white flashbulbs and daylight. With an 80C or 80D filter on the lens, the flash-illuminated parts of the subject will have correct color rendition, but the parts illuminated by daylight will register too blue. On the other hand, if you shoot with daylight color film and no filter, the flash-illuminated areas will be too warm. The solution in mixed flash and daylight situations is to use *blue* flashbulbs, or white flashbulbs covered by a blue flash shield or 80C or 80D gelatin filter. [*Note:* an 80D filter is for use with zirconium-filled flashbulbs such as the AG1, M3, and M5. For all other white flashbulbs use an 80C filter.]



Blue flashbulbs are made with blue-lacquered glass. They give a quality of light that produces natural-looking color with daylight type color-transparency films and with all color negative films except Ektacolor Type L. You can use blue flashbulbs with these films for indoor shooting, when flash is your only source of lighting, or you can mix the light from blue bulbs with daylight–for example, to provide fill-in lighting for an outdoor portrait. Because of this versatility, manufacturers now recommend standardizing on blue flashbulbs for *all* flash photography, including black and white.

Flashbulb exposure tip

Problem: You're shooting a picture on daylight type color-transparency film with a white flashbulb and an 80C filter on your camera lens. How do you figure the exposure? *Solution:* Use the guide numbers given by the manufacturer for the equivalent *blue* flashbulb. For example, a No. 25 white flashbulb and an 80C filter require the same exposure as a No. 25B flashbulb.

How to interpret the charts of commonly used flashbulbs

The following charts list flashbulbs commonly used for advanced amateur and professional photography. Use them to help you select the particular flashbulb you need for your equipment and purpose. The bulbs are grouped by type of base–glass, miniature, single-contact bayonet [S. C. Bay.], and medium screw. In general, pick a bulb you can use in your flash equipment without an adapter.

In each chart the first column at the left gives the designation of the flashbulb–AG1, 50B, etc. The bulbs are listed in approximate order of how much light output they give, first the white bulb, then its equivalent blue bulb, if any. Total light output is measured by units called *lumen-seconds*. However, just because one type of flashbulb has an output of about twice another bulb [say an M5 with a rating of 16,000 lumen-seconds compared with an AG1 with 7,000 lumen-seconds] doesn't necessarily mean you get twice as much *usable* light from the more powerful bulb. The synchronization setting, type of shutter, shutter speed, and reflector design are important contributing factors. Use the manufacturer's guide numbers to calculate your exposure.

Also given on the charts are the type of shutter [blade or focal plane] for which each bulb is primarily designed, the synchronization setting normally used with it, and the range of shutter speeds recommended at that setting. You'll also find information on the safe range of volts for firing the bulb, and the size and type of reflector for which it is designed. [Flashbulb guide number tables generally are based on the use of the flashbulb in a *polished reflector*. If you are using a folding-fan-type reflector, give about one stop more exposure than the guide number table indicates. With a satin-finish reflector, give about one-half stop more exposure.]

Commonly used flashbulbs and their characteristics

Glass base

Flashbulb designation	Color and approximate total light output in lumen-seconds	For use with this type of shutter	At this sync setting	Recommended range of shutter speeds	Safe range of volts for firing bulbs	Recommended reflector
AG1	white 7,000	blade*	M**	all marked speeds on camera	3 to 45	2-inch polished reflector
AG1B	blue 5,500	blade*	M**	all marked speeds on camera	3 to 45	2-inch polished reflector

*Also can be used with some late-model 35-mm cameras with focal-plane shutters. Check your camera instruction manual or the flashbulb maker to see if your camera's shutter is suitable for this use.

**Also can be used with F or X setting at speeds of 1/30 second and slower.

Flashbulbs and their characteristics [*continued*]

Miniature [no pin] base

Flashbulb designation	Color and approximate total light output in lumen-seconds	For use with this type of shutter	At this sync setting	Recommended range of shutter speeds	Safe range of volts for firing bulbs	Recommended reflector
M3	white 16,000	blade*	M**	all marked speeds on camera	3 to 45	3-inch polished reflector
M3B	blue 8,500	blade*	M**	all marked speeds on camera	3 to 45	3-inch polished reflector
M5	white 16,000	blade*	M**	all marked speeds on camera	3 to 45	3-inch polished reflector
M5B	blue 8,500	blade*	M**	all marked speeds on camera	3 to 45	3-inch polished reflector

*Also can be used with some late-model 35-mm cameras with focal-plane shutters.
**Also can be used with F or X setting at speeds of 1/30 second and slower.

Single-contact bayonet [S.C. Bay.] base

Flashbulb designation	Color and approximate total light output in lumen-seconds	For use with this type of shutter	At this sync setting	Recommended range of shutter speeds	Safe range of volts for firing bulbs	Recommended reflector
5, 25	white 20,000	blade	M	all marked speeds on camera	3 to 45	4- to 6-inch polished reflector
5B, 25B	blue 9,500	blade	M	all marked speeds on camera	3 to 45	4- to 6-inch polished reflector

Single-contact bayonet [S.C. Bay.] base [*continued*]

Flashbulb designation	Color and approximate total light output in lumen-seconds	For use with this type of shutter	At this sync setting	Recommended range of shutter speeds	Safe range of volts for firing bulbs	Recommended reflector
6, 26	white 19,000	small focal plane*	M or FP	all marked speeds on camera	3 to 45	4- to 6-inch polished reflector
6B, 26B	blue 9,000	small focal plane*	M or FP	all marked speeds on camera	3 to 45	4- to 6-inch polished reflector

*For focal-plane 35-mm, 2 1/4 x 2 1/4 reflex, and 2 1/4 x 3 1/4 press cameras.

Medium screw base

Flashbulb designation	Color and approximate total light output in lumen-seconds	For use with this type of shutter	At this sync setting	Recommended range of shutter speeds	Safe range of volts for firing bulbs	Recommended reflector
11, 40	white 33,000	blade	M	all marked speeds on camera	3 to 45	6- to 7-inch polished reflector
11B	blue 15,000	blade	M	all marked speeds on camera	3 to 45	6- to 7-inch polished reflector
2, 22	white 70,000	blade	M	all marked speeds on camera	3 to 125	6- to 7-inch polished reflector
2B, 22B	blue 32,000	blade	M	all marked speeds on camera	3 to 125	6- to 7-inch polished reflector
31	white 81,000	large focal plane*	M or FP	all marked speeds on camera	3 to 45	6- to 7-inch polished reflector

*Includes focal-plane shutters on some 3 1/4 x 4 1/4 and 4 x 5 cameras. Check your camera instruction manual for shutter-speed sync information.

Medium screw base [*continued*]

Flashbulb designation	Color and approximate total light output in lumen-seconds	For use with this type of shutter	At this sync setting	Recommended range of shutter speeds	Safe range of volts for firing bulbs	Recommended reflector
3, 50	white 100,000	blade	M	not faster than 1/30 second	3 to 125	medium-size studio reflector
3B, 50B	blue 43,000	blade	M	not faster than 1/30 second	3 to 125	medium-size studio reflector

Flashbulbs not listed on the charts

The bulbs shown on the charts are those most commonly used by advanced amateur and professional photographers. You may also encounter the following flashbulbs, which are designed primarily for use with simple, inexpensive cameras, and have to work with them in an *emergency*.

M2 and M2B: These are miniature white and blue flashbulbs of the same size and shape and having the same base as the M3, M3B, M5, and M5B bulbs listed on the chart; however, their light output is approximately half. When used with a blade-type shutter, set the sync at F or X, and use a shutter speed of *no higher than 1/30 second.*

M25 and M25B: These are miniature flashbulbs [white and blue] with a light output similar to that of M2 and M2B bulbs. However, the timing of the flash is different. Set the sync at F or X and use a shutter speed of *no higher than 1/30 second.*

SM and SF: These flashbulbs have no wire or foil filler. Instead, a large amount of primer material on the lead-in wire provides the light when ignited. Their time to peak is very short–only five milliseconds. They sync at *all speeds* with shutters having an F setting, and at speeds of up to *1/125 second* with shutters having an X setting.

These bulbs are available in white only. They give light with a color temperature of about 3300K, rather than 3800K, as is the case with white wire- or foil-filled flashbulbs. They can be used with Type A film without a filter. If you use them with Type B film, try an 81 or 81A filter.

Flash exposure

In this section we give you some refinements and shortcuts regarding flash exposure which you may find useful in your work.

The method of using flash guide numbers to calculate exposure has been explained in detail in the lesson on indoor photography. For accurate, up-to-date information on flash guide numbers, always use the flash guide number tables on the flashbulb carton or in your film data sheet. *When calculating flash exposure, remember that exposure can vary, depending on the shutter speed you use. Be sure to check on the table of guide numbers on the flashbulb carton the guide number for the particular shutter speed you are using.*

Flash guide number chart

We include a sample flash guide number chart on the following pages so you can familiarize yourself with what a typical one looks like. Supplied by a manufacturer of flashbulbs, it gives guide numbers for a variety of white and blue flashbulbs used in amateur and professional photography.

In this chart, the guide numbers are shown opposite the flashbulb and shutter speed and directly below the exposure index for different types of films. The number in brackets beneath the name of each flashbulb indicates the kind of reflector to which the guide number applies: [1] 4- to 5-inch polished reflector, [2] 6 1/4- to 7 1/4-inch polished reflector, [3] studio reflector, [4] 3-inch polished reflector, [5] 2-inch polished reflector. When using a satin-finish reflector of the same size, add half a stop to your exposure.

Sylvania clear flashbulbs

Lamp Type	Shutter Speeds	Film Speed [Tungsten] 10 12 16	20 25 32	40 50 64	80 100 125	160 200 250	320 400 500	650 800 1000	1250 1600 2000	2500 3200 4000
Zirconium-Filled Flashbulb AG-1 [Class MF] 3800°K [5]	F, X, or M 1/30th	50	75	110	150	200	300	420	600	850
	F, X, or M 1/60th	42	60	85	120	170	240	340	480	700
	M only 1/125th	38	55	75	110	150	220	300	440	600
	M only 1/250th	30	44	65	90	130	180	260	360	500
	M only 1/500th	26	36	50	75	100	150	200	300	420
M-2 [Class MF] 3800°K [4]	Up to 1/60th	60	90	120	180	240	360	500	700	1000
Zirconium-Filled Flashbulb M-3 [Class M] 3800°K [4]	M Sync.									
	Up to 1/30th	85	130	180	260	360	500	700	1000	1450
	1/60th	75	110	150	220	300	440	600	850	1200
	1/125th	65	90	130	180	260	360	500	750	1050
	1/250th	50	75	100	150	200	300	420	600	800
	1/500th	40	60	85	120	170	240	340	480	650
	X Sync.									
	Up to 1/30th	95	130	190	260	380	550	750	1100	1500
	Focal Plane									
	Up to 1/30th	95	130	190	260	380	550	750	1100	1500
	1/125th	55	80	120	170	240	340	460	650	950
	1/250th	40	60	85	120	170	240	340	460	650
	1/500th	28	42	60	85	120	170	240	340	460
	1/1000th	20	30	42	60	85	120	170	240	340
Press 25 [Class M] 3800°K [1]	Up to 1/30th	95	140	200	280	400	550	800	1100	1600
	1/60th	90	130	180	260	360	500	750	1050	1450
	1/125th	75	110	160	220	320	440	650	900	1250
	1/250th	60	85	120	180	240	360	500	700	1000
	1/500th	46	65	95	130	190	260	380	550	750
	1/750th	34	50	70	100	140	200	280	400	550
Press 40 [Class M] 3800°K [2]	Up to 1/30th	100	150	200	300	420	600	850	1200	1650
	1/60th	90	130	180	260	360	500	750	1050	1450
	1/125th	75	110	160	220	320	440	600	900	1250
	1/250th	60	85	120	170	240	340	480	700	950
	1/500th	46	65	95	130	190	260	380	550	750
Focal Plane Lamp Type FP-26 [Class FP] 3800°K [1]	Up to 1/30th	100	140	200	280	400	550	800	1150	1600
	1/125th	48	70	95	140	190	280	380	550	800
	1/250th	34	48	70	95	140	190	280	380	550
	1/500th	24	34	48	70	95	140	190	280	380
	1/1000th	17	24	34	48	70	95	140	190	280
Type 2 [Class M] 3800°K [2]	Up to 1/30th	150	220	300	420	600	850	1200	1700	2400
	1/60th	130	190	260	380	550	750	1050	1500	2150
	1/125th	110	160	220	320	460	650	900	1300	1850
	1/250th	85	130	180	260	360	500	700	1000	1400
	1/500th	70	100	140	200	280	400	550	800	1100
Type 3 [Class S] 3800°K [3]	Up to 1/30th	200	280	400	550	800	1150	1600	2250	3200

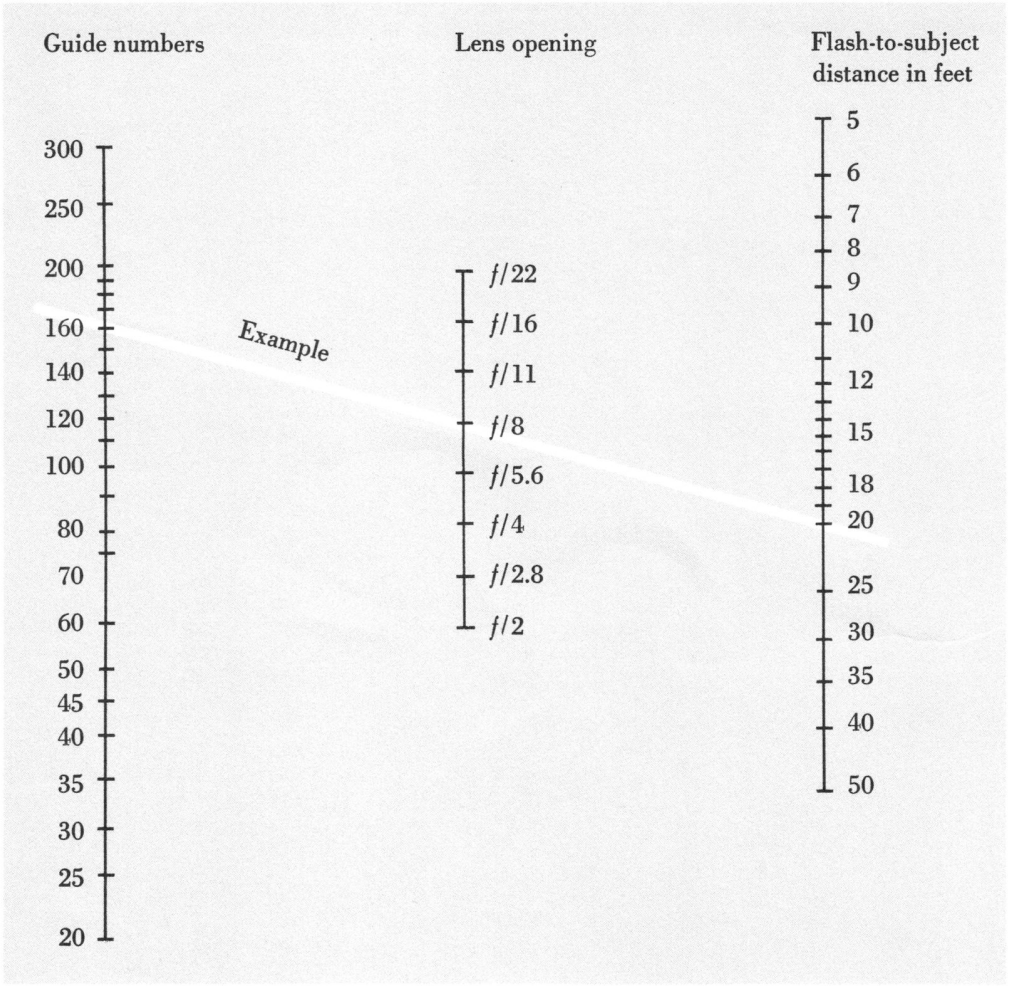
Sylvania blue flashbulbs

Lamp Type	Shutter Speeds	Film Speed [Daylight] 10 12	16 20	25 32	50 64	100 125	160 200
Zirconium-Filled Flashbulb AG-1B [Class MF] 6000°K [5]	F, X, or M 1/30th	38	48	60	85	120	150
	F, X, or M 1/60th	30	38	48	70	95	120
	M only 1/125th	28	34	44	60	85	110
	M only 1/250th	22	28	36	50	70	90
	M only 1/500th	18	24	30	42	60	75
M-2B [Class MF] 6000°K [4]	Up to 1/60th	42	55	70	95	140	170
Zirconium-Filled Flashbulb M-3B [Class M] 6000°K [4]	M Sync. Up to 1/30th	65	80	100	140	200	260
	1/60th	55	70	85	120	170	220
	1/125th	46	60	75	100	140	180
	1/250th	36	46	60	80	120	150
	1/500th	30	38	48	65	95	120
	X Sync. Up to 1/30th	65	85	110	150	220	280
	Focal Plane Up to 1/30th	65	85	110	150	220	280
	1/125th	42	50	65	95	130	170
	1/250th	30	38	48	65	95	120
	1/500th	20	26	34	46	65	85
	1/1000th	15	19	24	34	46	60
Press 25B [Class M] 6000°K [1]	Up to 1/30th	65	80	100	150	200	260
	1/60th	60	75	95	130	190	240
	1/125th	50	65	85	120	160	200
	1/250th	40	50	65	90	130	160
	1/500th	30	40	50	70	100	120
Focal Plane Lamp Type FP-26B [Class FP] 6000°K [1]	Up to 1/30th	65	85	110	150	220	260
	1/125th	32	40	50	75	100	130
	1/250th	22	28	36	50	70	90
	1/500th	16	20	26	36	50	65
	1/1000th	11	14	18	26	36	46
Type 2B [Class M] 6000°K [2]	Up to 1/30th	100	130	160	220	320	400
	1/60th	85	110	140	200	280	360
	1/125th	75	95	120	170	240	300
	1/250th	60	75	95	130	190	240
	1/500th	44	55	75	100	140	180
Type 3B [Class S] 6000°K [3]	Up to 1/30th	130	170	220	300	420	550

Shortcut method for determining flash exposure

Here is a scale which provides an easy one-step way to find the proper flash exposure when you know your guide number and flash-to-subject distance. It saves you the bother of doing arithmetic. [Directions for using this scale are on the facing page.]

Flash exposure scale



How to use the flash exposure scale: Take any straightedge–a ruler, cardboard, etc.–and place it across your guide number on the left-hand [guide number] scale. Then adjust the straightedge so it intersects your flash-to-subject distance on the right-hand scale. Where the straightedge intersects the middle [lens opening] scale, it indicates the *f* stop you should use for correct exposure. [If the straightedge crosses the lens opening scale between two *f* numbers, use the closest *f* number.]

For example, suppose your guide number is 160. You plan to stand 20 feet from your subject [with your flash on your camera]. You would position your straightedge as indicated by the bar marked "example" on the guide. It cuts across the lens opening scale at *f*/8. This is the lens opening you should use for correct exposure.

Now suppose you want to move in for a closer shot–say from a distance of 10 feet. Keeping the left-hand part of your straightedge on the 160 mark of the guide number scale, move it to cross the 10-foot mark on the distance scale. This time, your lens opening will read *f*/16.
[Flash exposure scale courtesy Sylvania Electric Products, Inc.]

How to establish your own flash exposure guide

The guide numbers supplied by film and flashbulb manufacturers are just what the name implies–*guides* only. They generally give good exposure results, but they may not be exactly the best for your particular equipment and working methods. For best possible results, we suggest you work out a set of guide numbers that are tailored to your own needs. If you do much flash photography, and want professional quality in your pictures, the following test for flashbulbs should be well worth the little time it takes to carry it out. Follow this procedure:

1 Load your camera with the type of film you most commonly use for flash photography. If you shoot both color and black and white with flash, you'll need to make a separate test for each type of film.

2 Place your flash unit *exactly 10 feet* from a subject. If most of your flash pictures are of people, a person is the logical choice as your subject. Conduct your test in a medium-sized room with white ceiling and light- or medium-colored walls, and place your subject a few feet away from the wall.

3 Select a convenient shutter speed–one you are likely to use in the majority of your flash shooting. A speed of 1/100 or 1/125 second may be suitable, or you may choose 1/200 or 1/250 second if you plan to shoot flash action pictures.

4 Find the guide number for the flashbulb, shutter speed, and type of reflector you are using. [Naturally, you should select a flashbulb designed for your flash unit, shutter, and camera, and one that will be most generally useful to you in your shooting.]

5 Divide this guide number by 10 [the number of feet the camera is from the subject] to get the recommended *f* stop for correct exposure. Set your lens at this opening.

6 Take one picture at this setting.

7 Next, without changing camera distance or shutter speed, make additional exposures as follows. *With color film:* Make exposures of one-half stop larger, one full stop larger, one-half stop smaller, and one full stop smaller. *With black-and-white film:* Make exposures at one full stop larger, two stops larger,

one full stop smaller, and two stops smaller. *Keep a record of all* f *stops.* [A good way to do this if you're using a person is to have your subject hold a card with the *f* stop printed on it. Then there's no possibility of getting the negatives or transparencies mixed up.]

8 Process the film [or have it processed] in your usual way. If you're processing the film yourself, *be sure to follow your normal standard procedure,* otherwise the validity of this test will be impaired.

9 Examine the resulting transparencies or negatives carefully. One should seem better than the others. [If the subject is a person, the skin tones are a good key area to study.] With negatives, you might try making prints to see which one gives the best results with your equipment and working methods. Then see which *f* stop you used for this picture.

To obtain your own flash guide number, simply *multiply the* f *stop that gave best results by 10.* For example, if the best picture was made at *f*/8, your guide number is 8 times 10, or 80. *Use this as your guide number whenever you shoot with the particular flashbulb, film, and shutter speed used in your test.*

What do you do if you want to use a different film or shutter speed with this same flashbulb? You must determine the ratio between your own flash guide number and the guide number given by the manufacturer. Do this simply by dividing the guide number you obtained in your test by the manufacturer's guide number. For example, if your guide number is 95 but the manufacturer's guide number is 110, divide 95 by 110. This gives you 0.86. [Carry out to two decimal places, and round off the second number if the division doesn't come out even.]

This ratio can be used to convert any manufacturer's guide number [for the flashbulb you used in your test] to a personal flash guide number. For instance, if the flashbulb manufacturer's guide number for a faster film or different shutter speed is 200, multiply this by 0.86, giving you your personal guide number of 172.

Make out your own chart of most commonly used personal guide numbers. Put them on a small card or piece of paper you can tape on the back of your flash reflector.

Since your test was made under average or normal conditions which you set up and are familiar with, you're now in a good position to judge what change in exposure, if any, you should make under other conditions. For example, if you shoot in a larger room than that in which you made your test, or one with darker walls, you should know just about how much you need to increase your exposure. In a smaller or lighter-walled room, you'll need to reduce exposure. After a little experience, you should be able to adjust your exposure for very accurate results in almost any situation you encounter.

How to calculate bounce flash exposure

One simple and widely used method of calculating exposure for bounce flash is the one we gave in the lesson on indoor lighting–use the normal guide number in the customary way, then *increase the indicated exposure about 2 1/2 stops.* Another system is to use the normal guide number but to divide it by *the total distance the bounce light travels.* That is, instead of using the direct flashbulb-to-subject distance as you normally would, use the flashbulb-to-reflecting surface [wall, ceiling, white cardboard, or whatever it is] plus the surface-to-subject distance.

Following is a rough guide to bounce flash exposure. The figures are based on Plus-X film, a camera-to-subject distance of 8 to 10 feet, and a room of medium size with medium-toned walls and white ceiling. Consider these figures as *approximate only*–a starting point for tests with your own equipment.

Bounce flash exposure guide

Flashbulb	Bounce exposure
AG1	1/30 second at *f*/5.6 to *f*/8
M25	1/30 second at *f*/8 to *f*/11
M5, 5, 25	1/60 second at *f*/8 to *f*/11
11, 40	1/60 second at *f*/11 to *f*/16
21, 22	1/60 second at *f*/16 to *f*/22

How to calculate exposure for fill-in flash plus daylight

Flash sometimes is useful for filling in shadows on your subject that are too dark in bright, contrasty sunlight. The most common application of fill-in flash is in outdoor portraiture–especially when using color film, which has less exposure latitude than black and white. Here's a good method for controlling fill-in flash for quick shooting when you don't have time to make more exact calculations. It will work with color film and the slower black-and-white films that allow you to use a shutter speed of 1/50 or 1/60 second in bright sunlight.

1 Set your shutter at 1/50 or 1/60 second.

2 Set your lens aperture at the *f* stop that will give correct exposure for the important sunlighted areas–in portraiture, this naturally would be the subject's face. Use an exposure meter to make this calculation.

3 Select the shooting distance you want.

4 Control the amount of light from the flashbulb by shielding it with one or more thicknesses of a *clean white handkerchief* as follows.

How to use a white handkerchief to control light from flash

If flashbulb is	With a blue bulb use	With a white bulb use
4 feet from subject	2 thicknesses	4 thicknesses
6 feet from subject	1 thickness	2 thicknesses
8 feet from subject	no handkerchief	1 thickness

If you have the time, here's a more exact method you can use, either with color or black-and-white film:

1 Use an exposure meter to determine the correct exposure for the daylight alone. The exposure should give you good details in your important highlight areas.

2 Set your camera's exposure controls for this exposure. For example, let's assume you're shooting with Kodachrome II, and that 1/100 second at *f*/8 will give good results.

3 Now find the guide number for the film, flashbulb, and shutter speed you are using. For example, if you happen to be using a No. 5B flashbulb, the guide number for Kodachrome II [ASA 25] and 1/100 second is 75.

4 Divide this guide number by your selected *f* stop to give you the flashbulb-to-subject distance you should use for correct exposure. In our example, 75 [the guide number] divided by 8 [the *f* stop] comes out to approximately 9. [You don't need to carry your division out to decimal places; just round off to the nearest whole number.] Therefore, the flashbulb should be placed at nine feet from your subject for full fill-in of the shadows. If you want less fill, use a greater flash-to-subject distance. The degree of fill required is a matter of personal taste and is best worked out by experimenting with your own equipment.

Obviously, the correct flashbulb-to-subject distance may not always be the shooting distance you prefer. A simple way to solve this is to have your flash unit on an extension cord. Then you can use any camera-to-subject distance you wish, and place the flash closer or farther away as necessary. An assistant can hold the flash, or you can clamp it to a light-stand or other support.

If your camera has interchangeable lenses, here's another possible solution. Place yourself at the required flash-to-subject distance with the flash on your camera. If the subject's image is too small, switch to a longer lens. If the image is too large, choose a lens of shorter focal length.

For close-up shooting, if the flash must remain on your camera, use the handkerchief method previously explained.

How to determine exposure when you're using more than one flashbulb

Sometimes, one flashbulb won't give you all the light you need for a large, distant subject. When using two or more flashbulbs *side by side,* or when light from two or more flashbulbs *overlaps* on a subject, follow this procedure:

For two flashbulbs, give *half* the exposure you'd give for one, or multiply the flash guide number by 1.4.

For three bulbs, give *one quarter* the exposure, or multiply the guide number by 1.7.

For four bulbs, give *one eighth* the exposure or multiply the guide number by 2.

[Of course, these directions only hold true if all the flashbulbs and reflectors are identical.]

If you use one flash as a mainlight to illuminate your subject, and another to light up a background or to backlight the subject, calculate your exposure for the *mainlight only.*

How many flashbulbs do you need?

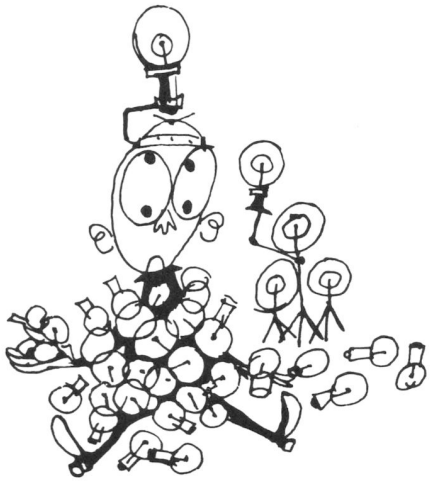
How do you find the number of flashbulbs you need for a large, distant subject? Here's a good method to use. It's useful for determining the correct amount of illumination for subjects such as a building at night.

1 Determine how far from the subject you must place your flashbulbs and what *f* stop you need to get the depth of field you want.

2 Multiply the flash-to-subject distance [in feet] by the *f* number. This gives you the guide number you need.

3 Divide the needed guide number by the guide number of one flashbulb of the type you plan to use.

4 Square this number to get the *total* number of flashbulbs you need.



To see how this works, let's take an example: Assume you want to photograph a building from a distance of 100 feet, and plan to place your flashbulbs close to your camera for frontlighting. You also decide you need a lens aperture of *f*/8 to give you adequate depth of field.

You multiply the flash-to-subject distance [100 feet] by 8, giving you a needed guide number of 800.

Also, assume you plan to shoot with film having an exposure index of ASA 160 and to use No. 5 flashbulbs at 1/25 second. The guide number for a single No. 5 flashbulb under these circumstances is 340.

Divide 800 by 340 and you get 2.3. [Carry your answer out to only one decimal place if it doesn't come out even.] Squaring 2.3 gives you 5.2. [To square a number, multiply it by itself.] Therefore, you need five flashbulbs to give you correct exposure.

You can place these five flashbulbs close together in a group, or fire them off one after the other in the same reflector. However, either way they must be fired *from the same location.*

Using floodlights to visualize the effect of multiple flash

Here's a good method to use with indoor multiple-flash setups, such as you might require when illuminating the interior of a house, factory, etc. Unless you have considerable experience with multiple flash, it's often difficult to visualize exactly what the effect of the lights will be, and to determine the exposure accurately. The following procedure makes things easier. It is based on using photofloods to arrange the lighting, then substituting medium-screw-base flashbulbs such as the No. 22, 22B, or 50 to make the picture. It requires you to use the "open-flash" exposure method. That is, you open your shutter, fire your flashbulb, then close the shutter. Therefore, it's practical only for situations in which the *flash alone* provides the illumination, not for mixed flash and daylight.

First, light your scene with No. 2 photoflood bulbs in reflectors. Arrange as many as you need to get the effect you want, but if you use more than three, be sure to put the additional ones in another circuit. [One 15-amp. fuse will handle only three No. 2 photofloods.]

When you've got the lights arranged the way you want them, take a reading with your exposure meter.

Find the correct flash aperture, using the following guide:

With No. 22 flashbulbs, your correct aperture will be the *f* number opposite the *4-second mark* on your exposure meter.

With No. 22B flashbulbs, correct aperture will be opposite the *2-second mark.*

With No. 50 flashbulbs, the aperture will be at *2.5 seconds.*

Set your camera for this indicated aperture. *Turn off the electricity.* [To be safe, actually pull out the plugs connecting your lighting equipment to electrical outlets.] Remove the photofloods and replace them with No. 22, 22B, or 50B flashbulbs. When you're ready to shoot, make an open-flash exposure. That is, open your shutter, turn on the electricity to fire the flashbulbs, then close the shutter.

How to convert flash guide numbers when shooting with a film rated at a higher-than-normal exposure index

The guide numbers given by flashbulb manufacturers are generally based on the normal exposure index as provided by the film manufacturer. However, you may not always choose to shoot at this exposure index. With a particular brand of developer and your personal working methods, another–usually higher–exposure index may work best for black-and-white films. Also, with both black and white and color, new films may be introduced with exposure indexes higher than those you find in tables of flash guide numbers. Here's a way to convert known guide numbers for use with higher film-speed ratings.

1 Determine how much faster the new rating is over the normal rating for which you know the guide number. Do this by dividing the new [faster] rating by the normal [slower] one. This gives you your "times greater" number, indicated in the chart below.

2 Look at the chart and find what number in the right-hand column corresponds with your "times greater" number.

Times greater	Multiply your guide number by
2	1.4
3	1.7
4	2.0
5	2.2
10	3.2

3 Multiply your known guide number by this multiplying factor–the number in the right-hand column. The result is your new, corrected guide number for use with the higher exposure index.

For example, if your film is normally rated at 125, with a known guide

number of 110, but you want to rate it at 250, you divide 250 by 125, giving you a "times greater" figure of 2. Looking at the chart, you see that a "times greater" figure of 2 corresponds to a multiplying factor of 1.4. Multiply your known guide number of 110 by 1.4 and you get a new, corrected guide number of 154. Use this with your film rated at 250 exactly the same as you'd use the old guide number with the normal film-speed rating.

Electronic flash

Calculating exposure for electronic flash is basically the same as it is with flashbulbs. Just as with flashbulbs, a guide number can be used. These guide numbers generally are supplied by the manufacturer for his own units. They are to be considered *guides only*, subject to change according to your own needs.

There's one important difference in the use of guide numbers for electronic flash and flashbulbs. With flashbulbs, the guide number may vary with the *shutter speed* you use. With electronic flash, the shutter speed generally has no effect on the exposure because the electronic-flash exposure usually is faster [shorter in duration] than even the highest shutter speed on your camera. It blinks on and off during the time your shutter is open. Thus, the highest shutter speeds can be used with electronic flash–*if your camera has a blade-type shutter and an X setting.*

However, with most *focal-plane shutters*, the highest shutter speed that can be used with electronic flash is about 1/60 second. An exception is the Copal Square focal-plane shutter found on some 35-mm single-lens reflex cameras. This type of shutter can be used with electronic flash up to 1/125 second.

How to obtain a working guide number for electronic flash

It's a good idea to establish your own working guide number for your electronic-flash unit by a simple, practical test. Here's a procedure to follow:

1 Select a room of average size with medium-toned walls. Choose a subject of the type you plan to use in many of your pictures–ordinarily this will be a person. Pose the subject a few feet from the wall and place your flash unit exactly 10 feet from the subject.

2 Load your camera with a relatively slow daylight type color-transparency film, such as Kodachrome. [Slight differences in exposure will be likely to show up more distinctly when you use a film of this type.]

3 Make a series of exposures, one each for all the *f* stops and the half stops between the marked stops on your camera. [To identify these shots, have your subject hold up a card each time with the *f* stop being used marked on it.]

4 Have the film processed by your photofinisher and examine the transparencies. Pick the transparency that gives the best results. [If you customarily view your transparencies by projection, you should run your test series through a projector before making your choice.] Take the *f* number you used to get the best exposure and multiply it by 10. This gives you your *personal guide number*. This number can be used to find electronic-flash guide numbers for other films by the method and chart given on pages 124 and 125.

Finding electronic-flash guide numbers for different films

The method described here is based on the beam candlepower seconds [BCPS] output of your electronic-flash unit. Using this method is generally considered to be a more accurate procedure than working with published guide numbers only. Some flash manufacturers supply you with the BCPS rating for their units; others do not. If you want to find the BCPS rating for your unit, first run an exposure test as just described. Then use the guide number you derive from this test, and the following chart.

The chart has three vertical columns–one for the film's ASA exposure index, one for the flash guide number, and one for the BCPS rating. Take a ruler or other straightedge and place it so it cuts through the ASA exposure index of the film you used in your test, and also through the guide number you derived from this test. Then see where the straightedge intersects the BCPS column. The number you get is the beam candlepower seconds rating for your unit.

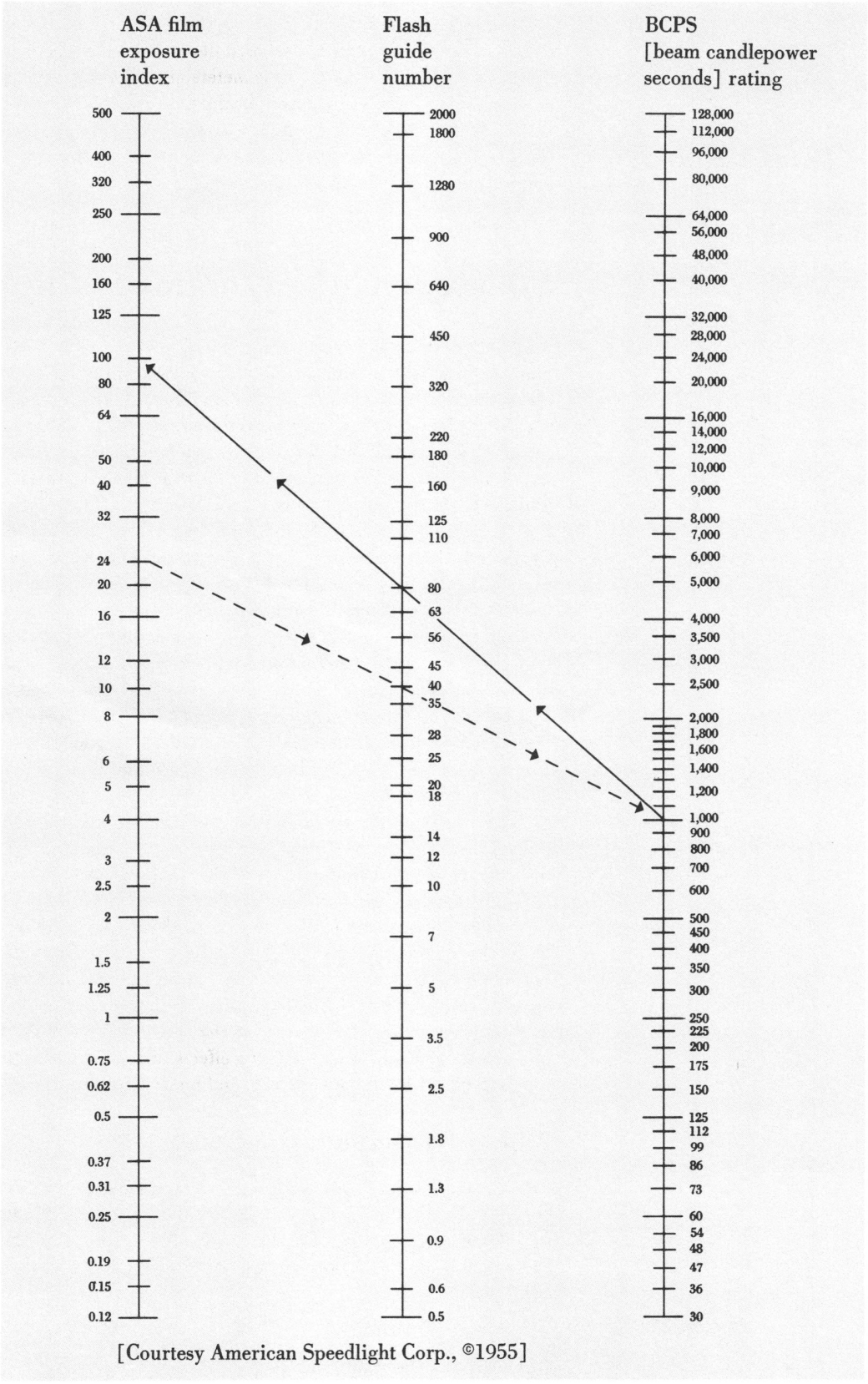
Once you've determined this basic figure, you can quickly find the correct guide number for any film you want to use. Just place the straightedge so it intersects your BCPS number in the right-hand column and the ASA exposure index of the film in the left-hand column. Then read your guide number where the straightedge cuts across the middle column. [If it doesn't cross exactly at a number, use the nearest number.]

An example is given on the chart. The photographer used Kodachrome II film rated at ASA 25, and got a guide number of 40. The lower line indicates how he placed his straightedge. This gave him a BCPS rating of 1,000 for his unit.

Next, the photographer wanted to know what guide number to use with a film he rated at 100. The upper line shows how he placed his straightedge to find this figure. It runs from 1,000 in the BCPS column to 100 in the exposure-index column. It cuts through the guide number column at 80–which is the guide number for the film in question.

The advantage of this chart is that it gives you the right guide number quickly, easily, and accurately for just about any film or exposure rating you're likely to use.

Guide number chart for electronic flash



[Courtesy American Speedlight Corp., ©1955]

Electronic-flash exposure meters

Still another way to calculate exposure for electronic flash is to measure its light output with a specially designed meter that reacts to the swift flash of light and holds the reading. These meters are relatively expensive compared to conventional meters, but are very useful for professional photography in a studio. Their use is demonstrated in some of the more advanced lessons in your Course. The manufacturer's directions should be studied and followed carefully when you use one of these meters.

Floods and other 'continuous' light sources

There are various incandescent sources of photographic lighting used for still photography, such as photoflood bulbs, 3200K studio bulbs, reflector floods and spots, and others. The importance of these light sources to photography should not be judged by the relative briefness of this discussion compared to the space we gave to flash. Generally speaking, the technical problems involved in the use of floods are simpler and easier to solve than those encountered when you use flash.

The light produced by the light sources covered here is *continuous* during the time the bulb or lighting unit is turned on. Therefore, you can determine exposure accurately with the aid of an exposure meter. There are no guide numbers to follow and no mathematics involved–unless you must calculate an exposure without a meter. [Later on, we have provided a table to help you do this. But for accuracy and convenience we urge you to use an exposure meter.

Another advantage of floods, spots, and other continuous light sources is that before you shoot you can observe the effect you get by placing the lights. This also is possible with electronic-flash units having modeling lights, but the cost of such units generally is considerably higher than that of a typical floodlight unit.

While we're on the matter of cost, we'd like to emphasize that, dollar for dollar, you can get more versatility from an inexpensive floodlighting outfit than from any other source of photographic lighting.

There are more expensive, heavy-duty professional units available, too, and if you become involved in professional work it may be well worth your while to purchase some of them. The main differences between inexpensive and more expensive lighting units are in the amount of light the unit produces and special features for operating convenience. But the owner of simple units [such as the basic lighting kit described in the lesson on indoor lighting] can create an endless variety of useful lighting effects for portraiture, still-life photography, fashion, advertising, and many other purposes.

Types of 'continuous' light sources

The continuous light sources for picture-taking can be grouped into six basic types: [1] photoflood bulbs–3400K, [2] blue photoflood bulbs–4800K, [3] 3200K studio bulbs, [4] reflector floods and spots–mostly 3400K, [5] sealed-beam floods, and [6] quartz-iodine lighting units. Let's take a brief look at each.

Photoflood bulbs

These look like ordinary frosted household bulbs. However, they burn at a much more intense rate, giving a higher light output than do ordinary household bulbs–and lasting for a shorter time. Their 3400K light output is correct for use with Type A color-transparency films. For maximum efficiency, they should be used in a metal reflector of proper design. However, they sometimes are used as replacements for ordinary bulbs in the existing lighting fixtures in a room to raise the overall level of illumination. If you use them this way, be careful that lampshades don't scorch or catch fire from the extra heat generated by the photoflood bulb. Lighting the bulb for only the brief time needed for shooting will help. This advice also applies to the blue photofloods and 3200K bulbs discussed later.

The No. 1 [250-watt] and No. 2 [500-watt] photoflood bulbs have medium screw-in bases and are the most generally useful. They are designed for use in 12-inch metal reflectors. The No. 4 [1,000 watts] has a large base called a "mogul" base and requires a special socket and reflector. The average life of these bulbs with normal use is three, six, and ten hours respectively. The big advantage of photoflood bulbs is their relatively low cost.

Blue photoflood bulbs

These bulbs have the same construction as ordinary photofloods. The only difference is their blue-tinted glass, giving a light of 4800K. They are designed to be used in color photography as fill-in lights to supplement daylight. This 4800K light is considerably warmer than the quality of daylight for which daylight color films are balanced. Therefore, *these bulbs should not be used as the sole source of illumination or the results will be too reddish.*

3200K studio bulbs

Generally these are very similar in size and shape to the 3400K photoflood bulbs just mentioned. However, they give off a slightly warmer [3200K] light, have a longer life, and are somewhat more expensive. Also, their light output and color quality tend to remain more constant than is the case with 3400K bulbs. For these reasons they often are preferred by professional photographers, to whom consistency of results is important. The longer life also reduces the chance of your having to replace a bulb in the midst of a shooting session.

The 3200K bulbs are designed for use with Type B color-transparency films. When used with a Type A film, an 82A filter or its equivalent should give normal color balance.

Studio bulbs are available in various sizes and strengths from 250 watts up to 1,500 watts. As with the photoflood bulbs, the smaller sizes have a conventional medium screw-in base, and are designed for use in 12-inch reflectors; the 1,000- and 1,500-watt sizes have a large size mogul base, and require special sockets and larger reflectors.

Reflector floods and spots

Some typical reflector floods and spots are illustrated in your lesson on indoor lighting. Their characteristic feature is their mushroom shape. The silvered, inside surface of the bulb acts as a reflector to direct the light in a controlled beam. These floods and spots offer the advantages of compactness and convenience, since they do not require the use of a metal reflector, as is the

case with the photoflood and 3200K bulbs we've previously discussed. For this reason, they often are used on location shooting. Reflector-type bulbs are available in three basic styles–broad-beam floods, medium-beam floods [mostly for movie use], and photospots.

Broad-beam flood: Designated RFL2, this is a 500-watt, 3400K bulb that gives a wide, floodlight-type [90-degree] beam. It produces approximately the effect of a No. 2 photoflood in a reflector. It is frequently used for general indoor still photography when the convenience of a built-in reflector is needed. [*Note:* A 3200K version of the RFL2 also is available from some manufacturers.]

Medium-beam floods: These are relatively small 3400K reflector-type bulbs primarily designed for use in groups of two or four on movie-bar lights. The beam covers a spread of from about 30 to 40 degrees, depending on the model. However, they sometimes are used in still photography when a small, concentrated light source is desired. Typical bulbs of this type include the PH/375 [375 watts], the even more compact R-30–available in a 375-watt type designated EBR and a 300-watt type designated BEP–and the extremely compact DAN [200 watts]. An advantage of these very small DAN bulbs is that a considerable number of them–up to seven–can be burned on a single 15-ampere fuse, thus allowing you great variety and freedom in setting up complex lighting arrangements.

Photospot: The RSP2 is a 3400K reflector-type bulb that throws a narrow [20-degree] beam. It's used for spotlight effect in indoor lighting setups.

Sealed-beam floods

These are relatively powerful floods constructed on the same principle as automobile sealed-beam headlights. They utilize a number of small lenses that concentrate the light into a beam which covers an area equal to that seen by a wide-angle movie lens. They are primarily designed for movie use. Sealed-beam units having both tungsten [flood] filaments and quartz-iodine tubes are available.

Quartz-iodine lighting units

One of the most recent innovations in photographic lighting equipment is the use of a quartz-iodine tube in a small, powerful lighting unit. The quartz-iodine [also called halogen] tube concentrates an extremely bright light into a small area. Units are available with special accessories, such as diffusers, barndoors, and filters to convert the color quality of the 3400K light to daylight or 3200K. Sealed-beam quartz-iodine lamps with daylight quality have recently been developed. The daylight color is produced by coating a special filter on the glass lens of the unit. Quartz-iodine lighting units maintain uniform light output and color quality throughout an average life of 12 hours. They are used both in motion-picture and still photography when a compact, portable, but powerful continuous light source is required.

Exposure

Obtaining correct exposure when working with floods generally is much simpler than when using flash or electronic flash. Accurate exposure calculations usually can be made quickly and easily with either a reflected-light or incident-light exposure meter.

Reflected-light meter

In general, a reflected-light meter should be used indoors in the same manner as for outdoor photography. That is, use a close-up reading for the most accurate results. In portraiture, close-up readings should be taken from the face. If you want more detail in shadow areas, or if the subject is wearing dark clothing and you don't want it to register too dark, remember to give additional exposure. If your subject is too small to give you an accurate reading, prop up a neutral gray card in the same position as the subject, facing a halfway point between your mainlight and your fill. Take a reading from the card and use that as the basis for your exposure setting.

Only the mainlight and fill-in light should be on when you take your reading. This is to make sure you're reading only the light reflected from your subject and not such things as a bright background or accent light behind the subject. Having background or accent lights on when you take a reading may give you too high a reading and result in underexposure.

If you wish, take a separate close-up reading of the background with the background light turned on to be sure it is illuminated properly. [In most cases it's best to have the background either distinctly lighter or distinctly darker than the subject.] However, after a little experience, most photographers learn to judge background illumination by eye alone.

Incident-light meter

For accurate indoor readings with an incident-light meter, you should hold the meter close to the subject with its cell facing the camera. Be sure to have both mainlight and fill turned on when you take your reading.

The danger of getting a misleading reading because of background or accent lights is less with an incident-light meter than with a reflected-light type, because with an incident meter the light-gathering cell is turned away from any light sources that are behind the subject. However, if a source other than the main and fill throws direct light onto the incident-light meter, be sure to turn this light off when taking a reading.

Remember—an incident-light meter gives you an average reading for *all* the light falling on the subject. Generally, the exposure it indicates will be close to correct for skin tones. Read the advice given by the meter's manufacturer regarding its use and the way to interpret it for best results with subjects that are lighter or darker than normal. [This general information about incident-light meters also applies to reflected-light meters when they are used with an incident-light attachment.]

When you don't have a meter

For the most accurate results, we urge you to obtain and use a good exposure meter when photographing by floods. However, if you don't have a meter and must take a picture by photofloods, the following table may prove useful. The guide numbers given here should be used in the same way you use flash guide numbers. Just divide the number by the light-to-subject distance to find your *f* stop. [A dial-type calculator for floodlights that gives readings directly in *f* stops and shutter speeds is available from Kodak.]

Flood exposure guide numbers

Photoflood bulbs	Shutter speed	Exposure index*							
		8	10	12	16	20	25-40	50-80	100-160
four No. 1 [two on each side of subject at 45 degrees] *or* two No. 2 [one on each side of subject at 45 degrees] *or* one No. 4		**Guide numbers**							
	1 second	75	80	90	105	115	150	210	280
	1/5 second	32	36	40	46	50	65	95	130
	1/25 second	15	16	18	21	24	30	42	60
	1/50 second	10	12	13	15	17	21	30	42
	1/100 second	7	8	9	10	12	15	21	30

*With ortho film, use tungsten index.

Tips on using floodlights

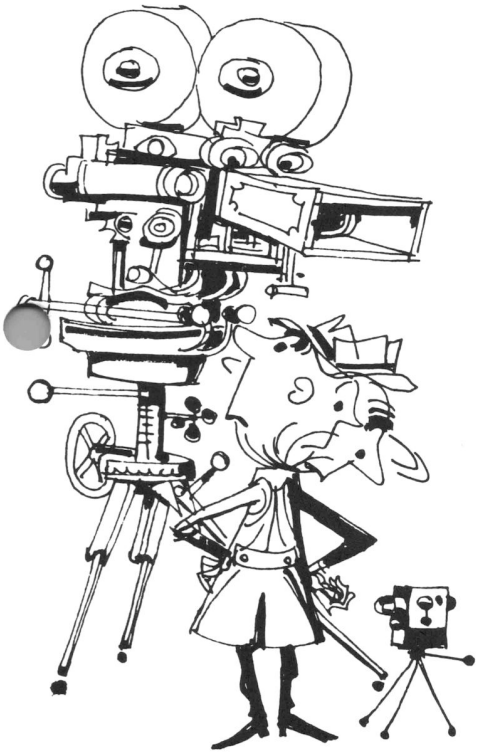
To get the most efficient light output and correct color temperature of light from a flood, you should use it at a voltage recommended by the bulb manufacturer [115 to 120 volts, in the case of the majority of bulbs we've discussed here]. If the voltage is too low, which may happen if you burn too many bulbs on one circuit, the bulbs will give a dimmer, warmer light. On the other hand, too high a voltage will burn the bulb out more quickly and cause it to give off a cooler, more bluish light.

As a bulb gets older it tends to give off a dimmer, warmer light. [This is especially true of the relatively inexpensive photoflood bulbs. The quartz-iodine units, however, maintain quite even light output and color quality throughout their entire life.] Color temperature is relatively unimportant in black-and-white shooting, and a bulb can generally be used as long as it continues to give off bright enough light for working purposes. For color work, however, "tired" bulbs near the end of their average working life should not be used. Keep a record of the approximate number of hours you have used the bulb, and when it approaches the end of its average life [as indicated by the manufacturer] replace it with a fresh bulb or use it only for black-and-white film.

Use reflectors of the size recommended by the bulb manufacturer. Also, keep your reflector surfaces bright and clean.

9

Moviemaking: film and equipment



In motion-picture photography, just as in still photography, equipment and materials have been continuously refined and improved–with particularly rapid changes in recent years. Today, exposure automation, zoom lenses, electric drive, sharper and faster films, improved screens, and better projectors make it easier than ever before to produce movies that are good from a technical standpoint. In fact, the top quality possible with 8 mm now rivals that of 16 mm a few years ago in terms of image sharpness and fine grain. In this section we'll cover some of the more important technical aspects of motion-picture photography. However, remember that with movies just as with stills, technique is only a means to an end. The test of a good photographer is *how effectively and imaginatively he uses his tools* to communicate ideas and emotions through pictures.

Choosing a motion-picture film

In choosing a film for motion-picture shooting, there are several things to consider. Let's take a look at these.

Camera size and type: Is your camera an 8-mm, 16-mm, or 35-mm type? Does it accept rolls of motion-picture film, or is it a magazine-loading type? Be sure to select a film of the correct size and load [roll or magazine] for the equipment you plan to use.

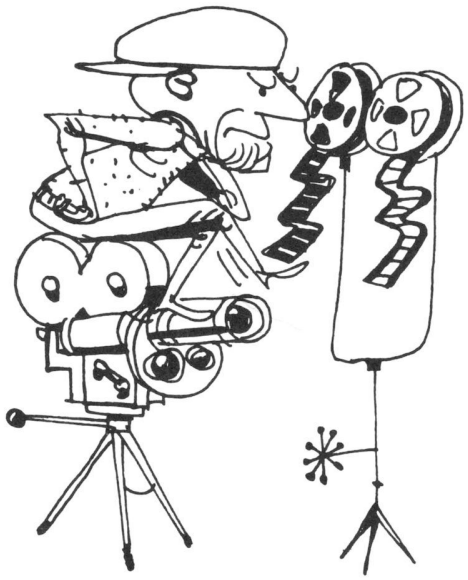
Color or black and white: The great majority of amateur movies and many professional films are shot in color because of the realism and beauty that color gives. In fact, some local suppliers don't even carry 8-mm black-and-white film because the demand for it is so slight. However, you can obtain black-and-white 8-mm film from larger photo dealers and from mail-order supply houses. We suggest you keep an open mind about the relative merits of color and black and white. Reasons of economy aside [black and white is less expensive], there

are some subjects that lend themselves better to black and white than to color. *Base your choice on the needs of the subject and what you want to say.*

Negative or reversal: As you may recall from the discussion in the movie lesson, two basic types of motion-picture film are available–negative and reversal. [Also, a few films are available that will produce either a negative or a positive, depending on how they are processed.]

Negative film produces a negative image from which a positive print for projection is printed. It often is used in professional film-making because you can use a work print for editing [saving wear and tear on the original negative] and then make any number of final release prints that may be required. Some advanced amateurs prefer negative film, too, because they want to protect the original footage from the danger of dirt and scratches to which it may be exposed during editing and projecting.

Black-and-white negative film is generally available in 16-mm and 35-mm sizes only, not in 8 mm. Color-negative film is currently available only in 35 mm.



With reversal film, you get a positive image. You can project the same film you exposed in your camera. *Therefore, for reasons of economy and convenience the vast majority of amateur movies are shot on reversal film.*

It is possible to have duplicate films made from a reversal film. You might edit your original footage, send it to a lab for duplicating, then save the original and use the duplicate for projecting. If the film is a valuable one, the extra expense and trouble may be well worth your while. It is much easier to make a satisfactory duplicate from 16 mm than from 8 mm. There is usually some increase in contrast and loss of sharpness in the duplicating process, and 8 mm is just too small for the image quality to hold up well when duplicated.

When a professional 16-mm or 35-mm movie is shot on color-reversal film, a common procedure is to make a duplicate color negative from the original. This *internegative*, as it's sometimes called, then can be used to produce color or black-and-white prints. This procedure protects the original footage, but is too expensive and cumbersome to be practical for most amateurs. Another possibility is to have the original film duplicated on a color-reversal film especially designed for this purpose.

Film speed versus fine grain: Just as in still photography, don't choose a film that's faster than you really need. The slower films tend to have less grain and produce a sharper image, which is particularly important in motion-picture photography, where the image may be enlarged enormously when projected onto a screen. [For example, an 8-mm movie frame, about 3/16 inch wide, may be projected to fill a screen 4 feet wide!]

Sometimes, however, you may need a fast film to get your pictures. For example, in documentary available-light shooting, you might choose one of the high-speed black-and-white films. The increase in grain could be a small price to pay for realism and spontaneity.

The following tables–one for color and one for black and white–list some popular 8-mm and 16-mm motion-picture films. The films are listed by manufacturer, in alphabetical order.

Note: A number of cameras now are available to accept Super-8 film. Super-8 film is supplied in quick-loading plastic magazines that hold 50 feet of film 8 mm wide. Because the film is 8 mm in width, the magazine does not have to be turned over at the end of a 25-foot run. The picture area of the Super-8 frame is approximately 50 percent larger than the area of a standard 8-mm frame.

Color movie films [8 and 16 mm]

Manufacturer and film name	Size	Exposure index [with light source for which film is balanced]
Agfa		
Agfachrome CT13S [daylight]	8 & 16	16
Agfachrome CK [3400K]	8 & 16	32
Ansco		
Anscochrome D/50 [daylight]	16	50
Anscochrome D/100 [daylight]	16	100
Anscochrome T/100 [3200K]	16	100
Anscochrome D/200 [daylight]	16	200
Moviechrome Daylight Type	8	20
Moviechrome Type A	8	16
Dynacolor		
Dynachrome 25 [daylight]	8	25
Dynachrome 40 [3400K]	8	40
Kodak		
Ektachrome Commercial Film Type 7255 [3200K]*	16	25
Ektachrome ER Film Daylight Type	16	160
Ektachrome ER Film Type B [3200K]	16	125
Ektachrome MS Film Daylight Type	16	64
Kodachrome II Daylight Type	8 & 16	25
Kodachrome II Type A [3400K]	8, Super-8 & 16**	40

*Designed to provide a low-contrast original from which color release prints can be made.
**At this printing, the only film available for Super-8 cameras is Kodachrome II Type A. However, other manufacturers are expected to offer film in this size.

Black-and-white movie films [8 and 16 mm]

Manufacturer and film name	Size	Reversal	Negative	Exposure index [daylight]
Ansco				
Super Hypan Negative	16		X	200
Super Hypan Reversal	16	X		200
Versapan Negative	16		X	80
Du Pont				
Superior 2 [936A]	16		X	125
Superior 3 [937A]	16		X	250
Superior 4 [928A]	16		X	320
Panchromatic [914A]	16		X	32
Rapid Reversal [930A]	16	X		64
High Speed Rapid Reversal [931A]	16	X		160
Ilford				
Pan F Negative Cine Film	16		X	50
FP3 Negative Cine Film	16		X	125
HP3 Negative Cine Film	16		X	400
HPS Negative Cine Film	16		X	800
Kin-O-Lux				
Kin-O-Lux TV	8 & 16	X		64
New Gold Seal	8 & 16	X		200
Kodak				
Plus-X Reversal Movie Film	16	X		50
Plus-X Negative Movie Film	16		X	80
Tri-X Reversal Movie Film	16	X		200
Tri-X Negative Movie Film	16		X	320
Double-X Panchromatic Negative Movie Film	16		X	250

Black-and-white movie films [8 and 16 mm] [*continued*]

Manufacturer and film name	Size	Reversal	Negative	Exposure index [daylight]
Perutz				
Perkine U15	8	X		25
Perkine U21	8	X		100
Perkine U27	8	X		400

Filters

The uses of filters in motion-picture photography are basically similar to their uses in still photography. Let's briefly review these uses here.

Colored filters: Red, yellow, green, and other colored filters can be used with black-and-white motion-picture films to help you control the tonal values in a subject. You might use one of these filters to intensify the mood of a picture [making the sky in a scenic shot go dramatically black, for example] or to separate tonal values [to make a subject stand out more strongly against its background, for example]. Use the filter chart on pages 38 and 39 as a guide.

Conversion and light-balancing filters: These are used in motion-picture photography to enable you to shoot Type A or Type B film in daylight, or daylight film by artificial light. See the accompanying chart for the filters and exposure indexes recommended for use with a number of popular motion-picture films.

Neutral density filters: These are useful in motion-picture photography when you want to reduce exposure without stopping down the lens. They can be used with color film as well as black and white because they do not alter the colors in the subject. Particularly useful are the 0.30 density [2X] ND filter, which cuts the light in half and requires one stop more exposure, the 0.60 density [4X], which allows only one-fourth of the light to pass and requires two stops more exposure, and the 0.90 density [8X], which passes only one-eighth of the light and requires three stops more exposure. For details about ND filters, see pages 26 through 30.

Polarizing filters: The uses of a polarizing filter in motion-picture photography are the same as in still photography–to reduce glare and soften or eliminate reflections, and to darken blue sky in color pictures without changing other colors in the scene.

Skylight and UV filters: These filters are used in color motion-picture photography for much the same purposes as in color still photography. They

are particularly useful when shooting distant scenes with a telephoto lens, to reduce the bluishness caused by atmospheric haze. Skylight and UV filters are not identical in their effect. Use the type recommended by the film manufacturer.

Fog filters: These are special filters sometimes used in motion-picture work to simulate the effect of fog in outdoor scenes shot at night. For best results, use a large lens opening with the filter, and be careful not to overexpose, because this may weaken or destroy the effect.

Filter factors

The manufacturer's instruction sheet accompanying your film usually gives filter information, including the amount of exposure increase, if any, needed with different filters.

With black-and-white movie films and colored filters, the exposure increase usually is given as a filter factor, just as it is with still films. In movie photography, the most practical way to increase exposure usually is to open the lens aperture. [A factor of 2 requires a full stop more exposure, 3 calls for 1 1/2 stops more, 4 calls for two stops more, etc.]

Some cameras with automatic exposure control have a dial that can be set to compensate for various filter factors. If you are using an automatic exposure movie camera that doesn't have this feature, follow this procedure. *Divide the film's exposure index by the filter factor and use this setting.* For example, if you are using a film with an exposure index of 64 and a filter with a factor of 2, you should set the dial at 32. If the filter factor is 4, use a setting of 16, etc.

With color films, any required exposure increase usually is given as a special exposure index for the film when used with a particular filter.

Conversion and light-balancing filters for movie films [8 and 16 mm]

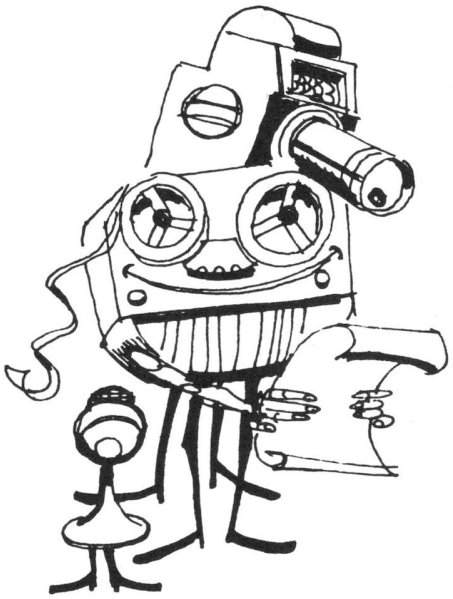
[The recommended filter appears in boldface type; beneath this, in regular type, is the exposure index to use with this filter.]

Manufacturer and film name	Daylight	3400K	3200K
Agfa			
Agfachrome CT13S	**no filter** 16	**80B** 8	
Ansco			
Anscochrome D/50	**no filter** 50	**80B** 25	**80A** 20
Anscochrome D/100	**no filter** 100	**80B** 50	**80A** 40
Anscochrome T/100	**85B** 64	**81A** 80	**no filter** 100

Conversion and light-balancing filters for movie films [8 and 16 mm]
[*continued*]

Manufacturer and film name	Daylight	3400K	3200K
Anscochrome D/200	**no filter** 200	**80B** 100	**80A** 80
Moviechrome Daylight Type	**no filter** 20	**80B** 10	**80A** 10
Moviechrome Type A	**85** 10	**no filter** 16	**82A** 12
Dynacolor			
Dynachrome 25 [daylight]	**no filter** 25	**80B** 12	**80A** 6
Dynachrome 40 [Type A]	**85** 25	**no filter** 40	**82A** 32
Kodak			
Ektachrome Commercial Film Type 7255	**85** 16	**81** 25	**no filter** 25
Ektachrome ER Film Daylight Type	**no filter** 160	**78A** 32	not recommended
Ektachrome ER Film Type B [3200K]	**85B** 80	**81A** 100	**no filter** 125
Ektachrome MS Film Daylight Type	**no filter** 64	**80B** 25	**80A** 16
Kodachrome II Daylight Type	**no filter** 25	**80B** 12	not recommended
Kodachrome II Type A	**85** 25	**no filter** 40	**82A** 32

Adding sound to motion pictures



Tape recorder: An inexpensive way to add sound to a motion picture is simply to run a tape recorder with the desired sound track at the same time you show the movie. The trick is to start both projector and recorder simultaneously, and to keep them in sync [synchronization]. You should run the projector and the recorder from the same power source [connect them to a double outlet plugged into the same wall socket]. Use one switch to start and stop both simultaneously. And use about six feet of leader on tape and film to give the machines time to get into sync.

A number of special sound attachments, mechanical and electronic, have been devised for the purpose of coupling a movie projector to a tape recorder. However, even with these aids, this method generally limits you to the use of narration and/or a musical background. It is not precise enough to give you the frame-by-frame accuracy you need to keep lip movements and dialogue in sync or make sound effects coincide perfectly with the action shown on the screen.

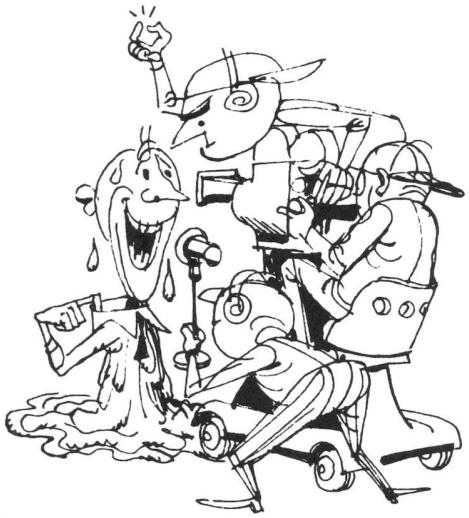
Magnetic stripe: This method involves adding a thin stripe of magnetic oxide to the full length of the film close to one edge. The sound track is recorded on this stripe. Since the sound track is on the film itself, there's no chance it will get ahead of or behind the projected image, and precise synchronization of sound and image is possible. For home movies, industrial training films, educational films, etc., magnetic striping often is a good choice because it is relatively inexpensive and easy to apply.

A number of magnetic sound projectors are on the market [both in 8-mm and 16-mm sizes] with a built-in sound-recording head that enables you to put music, narration, and sound effects onto the film as it runs through the projector. Accessory sound-recording heads also are available to adapt silent projectors to magnetic-stripe recording and playing. Some cameras, such as the Fairchild Cinephonic-8 and the Auricon, can record sound on magnetically striped film while the film is being shot.

You can obtain unexposed film to which magnetic striping has been added, but the usual procedure is to shoot the film, edit it, and then have the magnetic striping added by a lab equipped to provide this service. You record your sound track on the final, edited version of the film. If you attempt to edit a film *after* the sound track has been added, you lose a portion of the sound track each time you cut out a portion of the film.

With magnetic striping, you can shoot and project at 16-18 fps, although you'll probably get somewhat better quality at 24 fps. Incidentally, the matching sound for a particular frame of film doesn't run exactly beside it on the magnetic striping. The sound runs a number of frames ahead of the matching frame. The reason for this spacing between picture and sound is that for good quality the sound track must run smoothly and continuously through the sound head, while the picture moves intermittently. Thus the sound head works from a loop of film which feeds through it continuously after the film has passed behind the projector lens.

Optical sound track: This is the standard system used for a majority of professional films. The sound track–a narrow band running the length of the film close to one edge–is added *photographically to the film itself*. The most common type of optical sound track today is the *variable-area* type.



With the variable-area type, the sound track is wiggly. The bumps and hollows of the track correspond to vibrations of sound waves. On the print, the track is a clear band against black. As the track runs through the sound head, a beam of light shines through it. The sound track modulates the light beam, which is converted into impulses of electricity and amplified to operate a speaker.

Like magnetic striping, an optical sound track allows exact synchronization because the *track is on the film itself*. Moreover, the optical sound track can easily be printed on each release print made from the master negative. Thus it is practical for mass production of many duplicate prints. The standard projectors used in television, motion-picture theaters, and many audio-visual departments in schools and industry are designed to utilize an optical sound track or both optical and magnetic tracks.

There are two systems of adding optical sound–the *single system* and the *double system*. With the single system, *the sound track is recorded on the film in the camera at the time you shoot your pictures*. Thus, it's often used for documentaries and newsreels where a person is being interviewed on location. The reporter can ask questions and get answers, using a microphone, while a cameraman films the subject. Single-system sound is less expensive than double-system sound, and therefore sometimes is chosen for budget reasons. However, it provides less quality, and doesn't offer as much freedom and convenience in editing, as we'll explain.

With double-system sound, *the sound track is recorded separately*, then added to the final prints. It's called a "double" system simply because two separate units are utilized–the filmed image and its matching sound track. This system offers high quality and great flexibility. For example, the sound track may be *prerecorded*–that is, it may be completed before the film is shot. This often is done in commercials, where a script and storyboard have been prepared and the film is carefully and exactly planned. Sometimes, the sound track may be recorded at the time the film is shot. The sound can be put on a tape recorder and then transformed into an optical sound track later. Or the sound track can be prepared after the movie is shot, if this is more convenient. This is called *postrecording*.

As an amateur movie photographer, you'll probably find that using a tape recorder or magnetic striping is the most practical method for you. With these devices, you can add meaning to your films with music and narration. However, if you become involved in professional shooting, you'll probably need an optical sound track. The equipment required is elaborate and expensive, and its operation is generally entrusted to a technical specialist.

Movie-film timing rulers

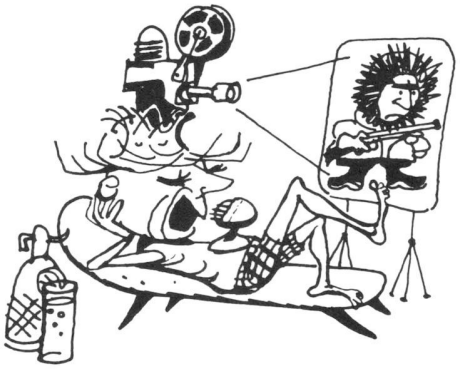
Often it's useful in editing a film to know exactly how long a sequence will run when projected, or it may be necessary to cut footage so that it will run for a predetermined length of time. You can actually count the frames, but it's much quicker and more convenient to measure the film. The two timing rulers reproduced here can help you do this.

One ruler is for 8-mm film and the other for 16-mm. The running time, in half-seconds, is marked on both these rulers for a projection speed of 16 fps and 24 fps. Place your film on the appropriate ruler along the white bar in the

middle. Be sure the first frame of the scene coincides *exactly* with Frame 1 on the bar. Measure off the number of seconds of running time you want [for a projection speed of either 16 or 24 fps] and cut the film at that point.

You may cut these rulers out and mount them on stiff cardboard for use when you are editing.

How to choose a motion-picture projector



A good projector is important for the fullest enjoyment of the movies you shoot. A great number of makes and models are available, and before you make a final selection you should shop around. Look at different projectors in the price range that interests you, ask for a demonstration, and get the advice of a reputable photo dealer. Here are some general pointers to help you make a good choice.

Do you plan to add sound to your movies in the future? If this is the case, you might be justified in buying a model equipped with a built-in sound-recording and playback component for magnetically striped films. Naturally, a projector with this feature is more expensive than a silent model of equivalent quality. But if you plan to go to sound, the extra cost may be well worth while.

Another possibility, if you have a tape recorder, is a projector that can be coupled to it so that sound and pictures run together. There are a number of devices for synchronizing a silent projector with a tape recorder. Ask your photo dealer for information and demonstrations.

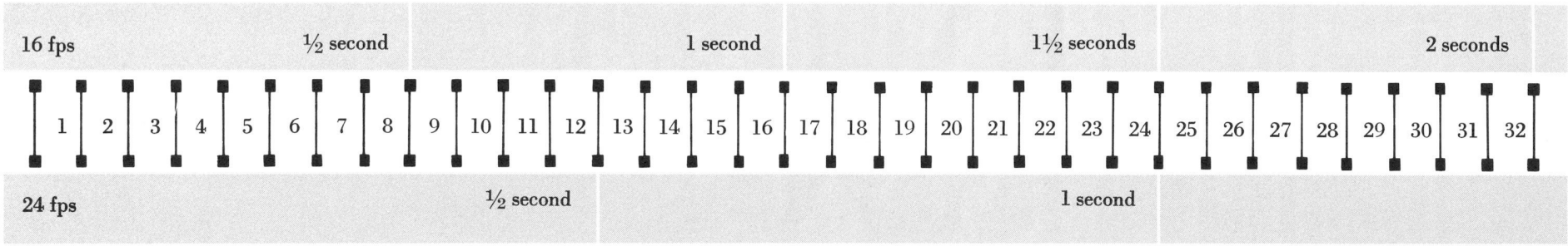
Automatic threading is a convenient feature found on more and more projectors. This can be a great convenience when you're showing your films. Instead of your laboriously threading the film by hand through the projector's film gate and onto the take-up spool each time you change reels, the projector does the rethreading automatically once the film is started on the right track. However, it is a convenience, not a necessity. You might find a good buy in a used projector or discontinued model that doesn't have this feature. A simple way to minimize the need for changing reels frequently is to splice a number of films together on a single large-capacity reel. Don't leave your 8-mm films on the small 50-foot reels returned by the processor. Put them on a 200- or 400-foot reel, and save yourself and your audience the inconvenience of frequent reel changing.

How much wattage do you need in your projector? It depends on the design of the projection lamp and the size of the room and audience for which the projector will be used. Highly efficient projection lamps have been devised that give bright light with relatively little wattage. They allow you to run a projector continuously for a long showing without its getting uncomfortably hot and possibly endangering the film. Many 8-mm projectors designed for use in a home with a small group of people use a projection lamp in the 150- to 300-watt range. For projection before larger groups, a 500- or 750-watt projector may be desirable. With 16-mm projectors, a 750- to 1,000-watt projection lamp is common.

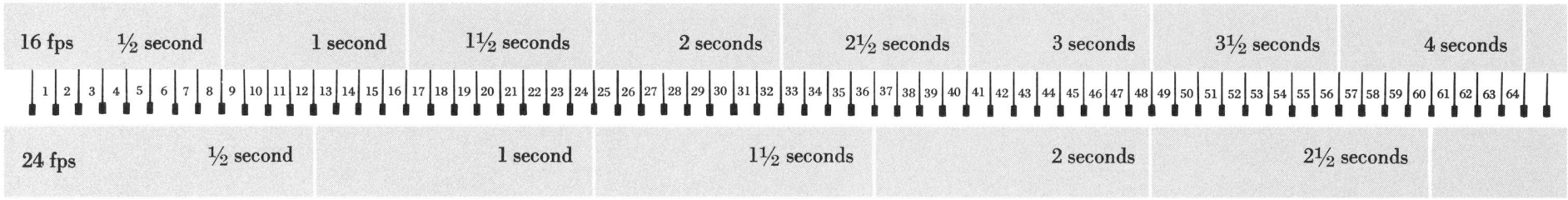
The focal length of the projector's lens is another consideration. The shorter the lens, the bigger the image you get for any projector-to-screen distance. The best size for your purpose depends on the size and physical layout of the room where you plan to project your pictures and on the size of the screen.

If you usually show your movies in a small room and don't have space to

16-mm Timing ruler



8-mm Timing ruler

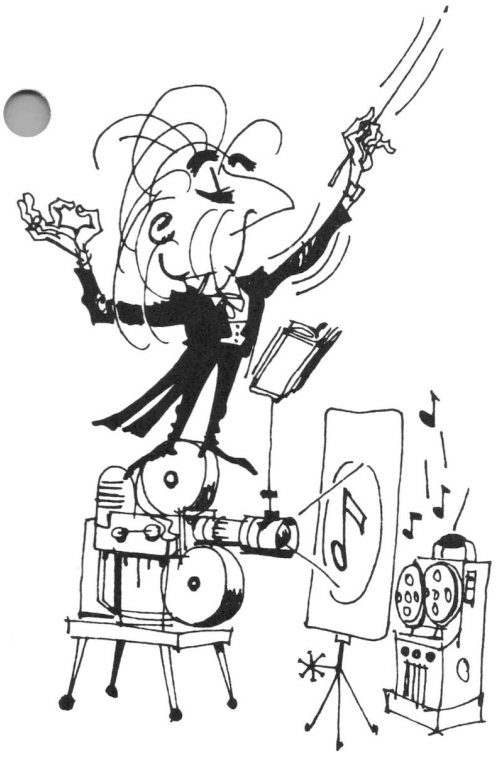


move the projector very far back from the screen you'll need a relatively short lens. For projection in a large room or auditorium, with the camera placed in the back of the room, you'll need a relatively long lens. [For an 8-mm projector and average home use, a lens with a focal length in the 15- to 20-mm range usually is about right.]

A convenient feature on many projectors today is a zoom lens. This lets you set up the screen and camera at any convenient distance from each other and then adjust the lens, getting a larger or smaller image until you fill the screen properly. [Zoom lenses for an 8-mm movie projector usually have a variable focal length of about 15 to 25 mm.] With a 16-mm projector, a 2-inch projection lens usually is standard and longer lenses and zoom lenses are available for some models.

In buying a projector, look first for a well-built, smoothly functioning mechanism and a good sharp lens. In particular, check the focusing control to see that it works smoothly, without tending to bind or slip.

Depending on the amount of money you wish to spend, there are a large number of convenient–but far from essential–extra features you can obtain on many models. These include a variable speed control that lets you speed up the film or slow it down, a device that lets you stop the film and project one frame at a time, a remote control that lets you sit in the audience and run the projector from a distance, and a device that automatically turns off the room lights when you turn on the projector.



Projection screens

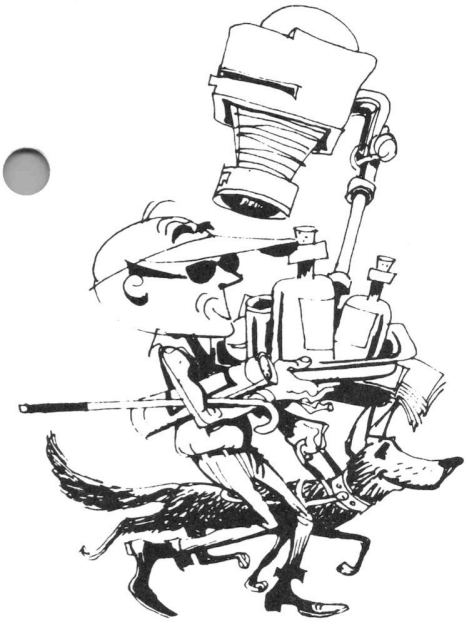
Screens for projecting movies and slides are made in a number of types of surfaces. A *silver* surface gives the brightest image when viewed straight on, but has the narrowest angle for good viewing–that is, the audience must sit quite close to the screen-to-projector axis. A *glass-beaded* screen is a good general-purpose surface. Although somewhat less bright than a silver screen, it gives a better picture for people sitting in side seats, away from the screen-to-projector axis. The widest good-viewing angle of all is provided by a *lenticular* screen. The lenticular surface has ridges which reflect the light in a broad beam. For small rooms, where the audience must sit close to the screen, the lenticular design can be very useful.

In setting up a projector and screen, here's a simple rule to follow for best viewing. It's called the "two and six" rule, and goes like this: The closest seat should be at least twice the screen's width away from the screen, and the last row of seats should not be farther away than six times the screen's width.

If you know the size of the room you plan to use for projection, you can figure the screen size that's best. For example a forty-inch screen is about right for most home viewing. Following the "two and six" rule, you could seat your audience in an area ranging from about seven feet to twenty feet in front of the screen. It's a good idea to buy the largest size screen you expect to use in the future–you can use less of the screen's width if you project the film in a room smaller than usual, but you'll have adequate size when you need it.

10

Color developing and printing



The growing use of color is one of photography's most exciting trends today. You can shoot color and have all the processing and printing done for you by a lab, as many photographers do. But there are rewards for doing it yourself, too –greater creative control and the fun and satisfaction of mastering a fascinating process. In this section we'll give you some advice to help you get started developing your color film. Then we'll go into the more complex subject of making a color print.

Color developing and printing is a fast-growing, ever-changing field, with new products and procedures appearing almost constantly. Be sure to follow the most up-to-date instructions from the manufacturer for details on the processing of any color film or printing paper.

Developing color film

If you've had some experience developing black-and-white film, you shouldn't find developing color film too difficult. The developing takes somewhat longer because there are more steps involved, and you must be more exact in your temperature control at certain stages, but this needn't present any serious problems.

Two developers are required for processing color-transparency [reversal] film–a *first developer* and a *second developer* [sometimes called the *color developer*]. Reversal film must be exposed to bright light at a point between the first and second development. [This step is sometimes called the *reversal exposure* or the *second exposure,* and is necessary to achieve the reversal of tones and colors from a negative to a positive image.] With color-negative film, only one developer is used, and no reversal exposure is required. In addition, there are special stop baths, hardeners, bleaches, fixers, and other solutions required for color developing. For details, see the charts later in this

section which outline the processing steps for several popular types of color films.

Equipment

The basic equipment you use for black-and-white developing generally will be sufficient for color work, with the following qualifications and additions.

You need a dial-type darkroom thermometer that is accurate to within a half-degree. Don't skimp on this item–it's important in getting good results.

Have enough extra bottles to hold the greater number of solutions needed in color developing.

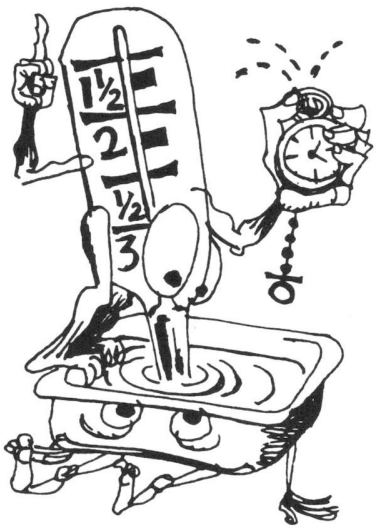
For reversal films you'll also need: [1] a No. 2 photoflood in a metal reflector or a reflector-type photoflood to give the film its reversal exposure, [except for Ansco films, where a 100-watt bulb is recommended] and [2] a stainless-steel developing tank with a wire reel, or a plastic tank whose reel has a *clear* plastic flange. [A black flange on a plastic reel doesn't let enough light into the film during the reversal exposure.]

All the necessary chemicals for processing different brands of color film usually are available in packaged kits from the manufacturer or in most cases can be purchased individually.

Mixing and storing solutions

Be particularly careful about mixing your solutions. Read all the instructions fully before you begin, and mix the chemicals in the order named and at the temperatures recommended. Be certain that one chemical or solution doesn't contaminate another.

Most solutions can be stored in glass, enamel, or stainless-steel containers. However, the bleaching solutions used in color developing are corrosive to metals and must not be stored in a stainless-steel container for any great length of time. Use glass, enamel, or enamel-lined stainless steel for this purpose.



Some solutions used in color developing don't keep as well as those used for black and white. Again, follow the manufacturer's advice in regard to keeping qualities. *Do not overwork your solutions.* Poor color will result.

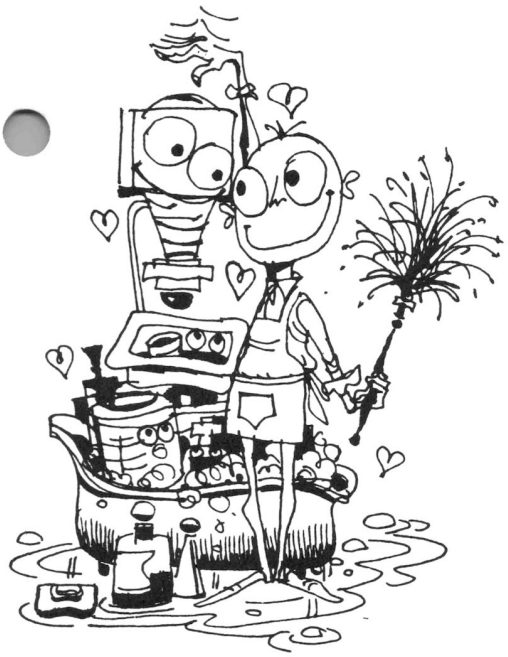
Temperature control

It's important that you keep your solutions at or near the same temperature. We suggest you mix all your solutions beforehand, put them in bottles, and let the bottles stand in a sink. Adjust the hot and cold water so that water of the correct temperature flows out of the faucet, fill the sink up to the level of the overflow drain, and let a continuous flow of water run through the sink.

The temperature of the *developing* solutions must be accurate to within a half-degree. Other solutions, rinses, and wash water may vary over a somewhat wider temperature range without harm. [See the following charts for details.]

Procedures

Standardize your working procedures so you can repeat them and get the same results each time. Be scrupulously clean. Have all your solutions and equipment ready before you begin.



If you develop color film only occasionally, you can use one tank and pour your solutions in and out. But for frequent processing [or processing a number of films at a time] it's much better to have a separate tank for each solution and to transfer your film from tank to tank. Just as in black-and-white developing, you can use a lightproof tank for the steps that must be carried out in total darkness.

The following charts summarize the steps used in processing a number of popular color films–both negative and reversal types. They are designed only to give you an overall view of the time and number of steps required. Unlike black-and-white films, color films generally must be processed in chemicals supplied by the film manufacturer. *Before you attempt to process any color film, read the detailed directions given by the manufacturer, and follow them exactly. Times, temperatures, and procedures are subject to frequent change.*

Color-negative film processing

Agfacolor process

Agfacolor film-processing kits for Agfacolor film are available in two sizes: 1 quart 2 ounces and 1 gallon. Chemicals for individual solutions are available in three sizes: 1 quart 2 ounces, 1 gallon, and 3 gallons.

Processing steps	Time in minutes	Temperature [degrees F.]
In total darkness or with Agfa Filter No. 170		
1 Agfacolor Film Developer S* or Agfacolor Film Developer F**	6-8 7-13***	68 [within 1/2 degree]
2 3 percent solution magnesium sulfate [Epsom salt] plus 1 ounce Developer S per 1 quart 2 ounces of solution	2	64-68
3 Wash	15	57-68
4 Agfacolor bleach	5	64-68
5 Wash	5	57-68
6 Agfacolor fixing bath	5	64-68

*Must be mixed 12 hours before use.
**A one-shot liquid developer concentrate for immediate use.
***Developing time depends on dilution of developer; see manufacturer's data sheet.

Agfacolor process [*continued*]

Processing steps	Time in minutes	Temperature [degrees F.]
Room lights may be turned on		
7 Wash	10	57-68
8 Wetting agent	1/2	57-68
9 Drying		
Total time [not including drying]	about 50	

Kodak C-22 process

For processing Kodacolor, Kodacolor-X, Ektacolor Type S, and Ektacolor Type L films. Kits of packaged chemicals are available in 1-pint and 1-gallon sizes.

Processing steps	Time in minutes	Temperature [degrees F.]
In total darkness		
1 Developer	12*	75 [within 1/2 degree]
2 Stop bath	4	73-77
3 Hardener	4	73-77
Room lights may be turned on		
4 Wash	4	73-77
5 Bleach	6	73-77
6 Wash	4	73-77
7 Fixer	8	73-77
8 Wash	8	73-77
9 Wetting agent	1	73-77
10 Drying		not over 110
Total time [not including drying]	51	

*For Kodacolor and Kodacolor-X film. For Ektacolor Type S or L films, develop for 14 minutes.

Color-transparency [reversal] processing

Agfachrome professional sheet film process

Processing chemicals for Agfachrome professional sheet film are available in 1-gallon and 3 1/2-gallon sizes, and replenishers in 5-gallon size.

Processing steps	Time in minutes	Temperature [degrees F.]
In total darkness		
1 Developer	13	75 [within 1/2 degree]

Agfachrome professional sheet film process [*continued*]

Processing steps	Time in minutes	Temperature [degrees F.]
2 Rinse	1/3	73-77
3 Stop bath	3	73-77
Room lights may be turned on		
4 Wash	7	73-77
5 Reversal exposure [expose 15 seconds from each side with a 500-watt photoflood at 3 ft.]		
6 Color developer	11	75 [within 1/2 degree]
7 Wash	14	73-77
8 Bleach	4	73-77
9 Wash	4	73-77
10 Fix	4	73-77
11 Final wash	7	73-77
12 Wetting agent	1/2	73-77
13 Drying		not higher than 115
Total time [not including drying]	68	

Anscochrome 75F process

For all Anscochrome films. Anscochrome 75F developing outfits are available packaged in 16-ounce, 1-gallon, and 3-gallon sizes; chemicals for individual solutions and replenishers are available in 3 1/2- and 10-gallon sizes.

Processing steps	Time in minutes	Temperature [degrees F.]
In total darkness		
1 First developer	12	75 [within 1/2 degree]
2 Stop bath-hardener	3	72-78

Anscochrome 75F process [*continued*]

Processing steps	Time in minutes	Temperature [degrees F.]
Room lights may be turned on		
3 Wash	3	70-75
4 Reversal exposure [15 seconds on each side at 4-6 inches from a fluorescent lamp]		
5 Color developer	12	75 [within 1/2 degree]
6 Stop bath-hardener	3	72-78
7 Wash	4	70-75
8 Bleach	4	73-77
9 Wash	4	70-75
10 Fixer	3 1/2	72-78
11 Wash	4	70-75
12 Stabilizing bath	1 1/2	72-78
13 Wash	3	70-75
14 Final rinse	1/2	72-78
15 Drying		not higher than 100
Total time [not including drying]	57 1/2	

Ektachrome [E-2 and E-3] processes

All chemicals for preparing a complete set of processing solutions are available in the Kodak Ektachrome film-processing kit, processes E-2 and E-3; individual components also are available separately. Note: E-2 films include *Ektachrome-X*, *High Speed Ektachrome Daylight Type*, and *High Speed Ektachrome Type B*. E-3 films include *Ektachrome* and *Ektachrome Professional Daylight Type* and *Ektachrome Type B*.

The chemicals for processing E-2 and E-3 films are the same. However, for general use, E-2 films should not be processed in chemicals that have been used for processing E-3 films, and vice versa. For best results, separate first and color developers should be used for E-2 and E-3 films. However, the balance of the chemicals may be used interchangeably.

Ektachrome [E-2 and E-3] processes [*continued*]

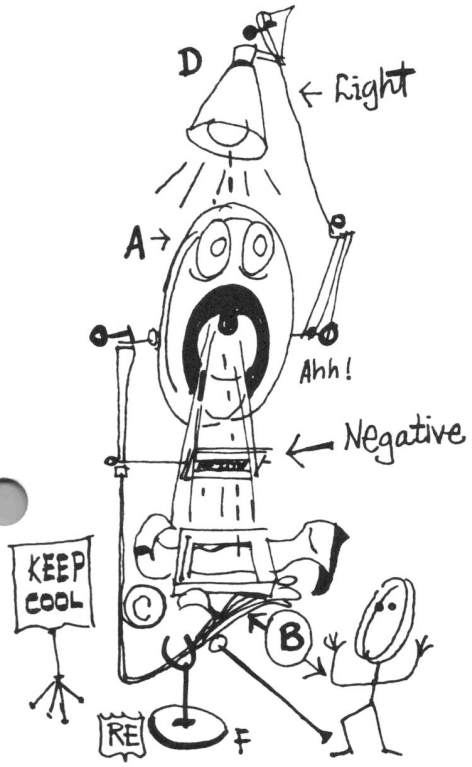
Processing steps	Time in minutes	Temperature [degrees F.]
In total darkness		
1 First developer	10	75 [within 1/2 degree]
2 Rinse	1	73-77
3 Hardener	3	73-77
Room lights may be turned on		
4 Wash	3	73-77
5 Reversal exposure*		
6 Color developer	15	73-77
7 Wash	5	73-77
8 Clearing bath	5	73-77
9 Rinse	1	73-77
10 Bleach	8	73-77
11 Rinse	1	73-77
12 Fixing bath	6	73-77
13 Wash	8	73-77
14 Stabilizer	1	73-77
15 Drying		not over 110
Total time [not including drying]	67	

*With roll film, remove reel from tank and expose both ends of reel to light from a 500-watt photoflood for 15 seconds; with sheet film, expose each sheet for 5 seconds, with film held between two 500-watt photofloods placed 2 feet apart.

Color printing

Making your own color prints is a fascinating and challenging aspect of photography. Improvements in materials, procedures, and equipment have put color printing within the reach of almost anybody with basic enlarging equipment and a good knowledge of black-and-white printing. However, color *is* more complex than black and white. This shouldn't deter you from trying your hand at color printing, but you must expect to spend some time and effort before you acquire the skill needed to make high-quality color prints.

The least complex method of color printing is to make the print from a color negative. [This is called the *negative-to-positive* process.] If you're trying color printing for the first time, we recommend that you work from color negatives. However, it's also possible to make color prints directly from color-transparency films. [This is called the *positive-to-positive* process.] More steps and time are required with this method. We'll discuss both negative-to-positive and positive-to-positive printing in this section.



In color printing from color negatives, just as in black and white, a longer printing exposure gives you a darker print and a shorter exposure gives you a lighter one. The thing that complicates printing exposures for color is that you must use filters to control the color in the print.

Color-printing paper has three layers of emulsion, each one recording approximately one-third of the visible color spectrum. Each one of these three layers must receive the correct exposure. This exposure depends not only on exposure time but also on the *color of the light* reaching the paper. To control the color of the light, you use one or more color filters between the light source and the paper. A combination of filters used in color printing is called a *filter pack.*

The most convenient way to make a color print is to make a single exposure through a filter pack. A second method [sometimes used in commercial printing] is to give the paper three separate exposures, each through a filter of different color–dark red, green, and blue. However, the three-exposure method makes it impractical to dodge or print in, and therefore most workers prefer to use a filter pack and a single exposure.

The correct use of filters is one of the keys to making a good color print. We'll have more to say about this important subject later on.

In even the simplest color-printing process, more steps are required than for making a black-and-white print. The total processing time for each finished print [not counting drying] may range from about half an hour [with a negative-to-positive process such as the Agfacolor short process] up to about an hour and 15 minutes [with a more complex positive-to-positive process such as Kodak color-print process P-111]. However, none of the individual steps is any more difficult than the steps in making a black-and-white print.

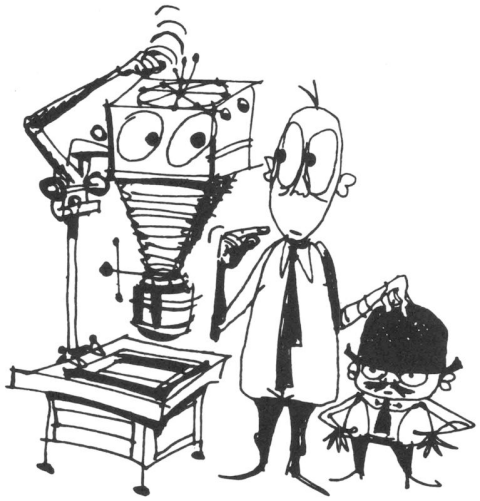
You'll need to be more exact with your temperature control, and be very careful not to contaminate one solution with another. If you've acquired good work habits in black-and-white printing, they'll pay off well in color work.

Just as with color developing, it is most important that you *read the manufacturer's instructions carefully–and follow them to the letter.*

Equipment for color printing

Most of the equipment you normally use in black-and-white printing also can be used to make color prints. You probably won't need to acquire much new

equipment if you intend to make just a few color prints. However, if you plan to make many, there are a number of special items you'll probably want to get as you go along.



Enlarger

Any good enlarger suitable for black-and-white printing can be used to make color prints. However, the light source preferably should be a tungsten bulb [such as a 211 or 212 enlarger bulb] rather than a fluorescent light. Some fluorescent-light enlargers are not suitable for color printing because of the quality of light they give–it requires special filtration for color work, leading to impractically long exposures.

If you plan to do much color printing, an enlarger with a *color head* is desirable. Usually, a color head is simply an enlarger head with a special drawer that lets you put filters *between the light source and the negative*. Using filters in this position, rather than below the lens, helps give you a sharper image. A more advanced type of color head, available on some makes of enlargers, includes built-in filters. This type of head is provided with three dials–one for magenta [blue-red], one for cyan [green-blue], and one for yellow. By adjusting these dials you can achieve the filtration you want.

On enlargers not having a color head, you can place your filters under the lens. If your enlarger is equipped with a filter holder for variable-contrast filters, you can use this. Another method is to fit the enlarger lens with a filter adapter ring and a gelatin-filter frame holder.

For sharpest quality, use only gelatin filters under the lens. The somewhat less expensive acetate color-printing filters are designed for use in a color head, but they aren't recommended for use under the lens.

If you do much color printing you may want to invest in a specially made color enlarging lens. But for occasional color printing, your regular enlarging lens probably will be fine. However, it is important that you keep your lens clean. Dirt, grease, or dust on the lens may cause only a slight loss of sharpness and contrast in a black-and-white print, but in a color print it also may adversely affect the color.

Filters

You need a selection of color-printing or color-correction filters for your printing exposures.

If you plan to use filters under the enlarger lens, you should obtain the very thin gelatin type of filter. Kodak or Agfa color-compensating [CC] filters belong to this type. If your enlarger has provisions for placing the filter above the negative, you can use the somewhat less expensive acetate type of filter, such as Kodak color-printing [CP] filters or Ansco or Spiratone color-compensating filters.

Filters for color printing usually are designated by their type [CC or CP], density, and color. For example, in a CP20M filter, the CP stands for color printing, the 20 stands for a density of 0.20, and the M stands for magenta. A CC40R is a red color-compensating filter with a density of 0.40, etc. [The greater the density, the stronger the filter.]

The filters you need depend on the process you use and the method you are following to determine correct filtration. For example, a basic set of filters for making Agfacolor prints requires eight yellow, eight magenta, and eight cyan filters. For making Ektacolor prints, six red, six magenta, and six yellow CC

filters are needed. Practically every color effect you want can be made by the correct combination of the filters in a basic kit. Refer to the manufacturer's instructions for details. In the latter part of this section we give you basic directions for working with filters.

If you are printing Kodacolor or Ektacolor negatives you also may need a special filter to compensate for the orange cast [caused by *color masks*] of these negatives.

Safelight

To prevent fogging, color-printing paper should be kept in total darkness as much as possible. However, manufacturers of color-printing materials supply special safelights for color printing. These include:

Kodak Wratten No. 10 [dark amber] for Kodak color-printing materials

Agfa No. 166 [for Agfa color-printing materials]

FR safelight [for FR color-printing materials]

Follow each manufacturer's directions regarding the wattage of the bulb to be used in the safelight, the distance between the light and your trays, and the length of time that the printing paper can safely be exposed to its light.

The safelights used in color printing generally give less light than the ones customarily used in black and white. Their purpose is to give you enough illumination to read the dial of your timer and to locate trays, filters, etc., rather than to enable you to make a visual check on how the development is progressing. After considerable experience, some color printers are able to judge under a safelight whether or not a print got the correct exposure. But usually it's necessary to wait until you turn on the room light.

Thermometer

Just as with color developing, you need an accurate thermometer for color printing. It should be accurate within a half-degree–the temperature tolerance allowable for most color developers. A large, easy-to-read dial is desirable because it makes it easier for you to check temperature when you're working in dim safelight illumination.

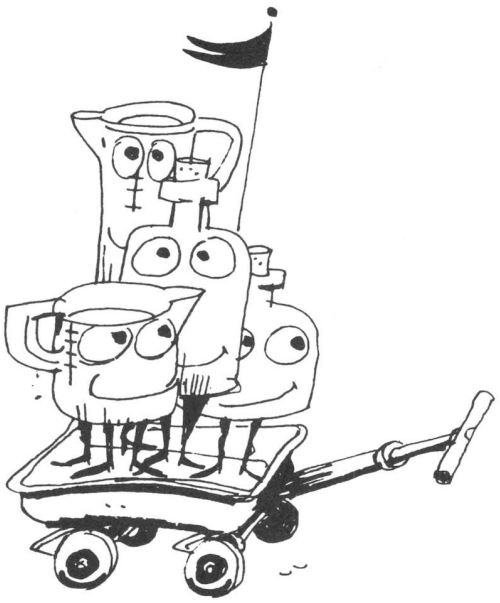
Voltage control

If the voltage of the line leading to your enlarger drops far enough, it will make the bulb burn with a more reddish light than normal. If the voltage increases, it can make the light more bluish than normal. Naturally, if these variations take place while you're making a printing exposure on color paper they can affect its color.

For occasional printing, make sure you don't plug your enlarger into a circuit off which any major appliances–refrigerator, vacuum cleaner, TV, electric iron, etc.–also are running. [When appliances like these turn on and off they may considerably affect the voltage on the circuit.]

If you do much color printing and want really precise control, a voltage control for your enlarger is a wise investment. There are two general types–manual and automatic. The first is simply a *rheostat* plus a *voltmeter* [the latter tells you what the voltage of the line is at any moment]. You check the voltmeter and then manually adjust the rheostat, if necessary, to maintain the level of voltage you want.

The second type, sometimes called an *automatic voltage regulator*, automatically adjusts the voltage and keeps it at a predetermined level. Prices



for voltage controls run from about $50 for the simplest variety up to $350 and more for the more elaborate types.

Darkroom timer

With a number of accurately controlled steps involved, a good darkroom timer can be a great blessing when you make color prints. The dial should be easily readable in dim light [or luminous so it can be read even in the dark]. A type that measures seconds as well as minutes and that can be connected to your enlarger to turn it on and off is very useful.

Extra trays and bottles

You'll probably need additional trays and bottles for your various solutions –and additional space to lay them out. [The FR color process is an exception– it can be done with as few as three trays.] Before starting to print color, lay out your trays and other equipment to be sure you have everything you need, and that it's arranged in the most convenient way possible.

Procedures

In the following charts we've outlined the basic steps [with times and temperatures] of various negative-to-positive and positive-to-positive color-printing processes. These are intended only to give you an overall view of each process, its complexity, and the length of time required. Before making any color prints, *read and follow the detailed instructions supplied by the manufacturer.*

Color prints from color negatives

Agfacolor long process

This process is intended primarily for making Agfacolor prints from Agfacolor negatives, although it also can be used with other color-negative films. This, rather than the Agfacolor short process, described a little later, is recommended for home-darkroom users.

You'll need a supply of Agfacolor paper [available in two contrast grades –normal and hard], a basic set of Agfa CC filters [eight yellow, eight magenta, and eight cyan], and a set of six processing chemicals, including Agfacolor developer, stop-fix, bleach-fix, bleaching bath, buffer, and antifade. An Agfa safelight No. 166 may be used during printing exposure and processing.

Processing steps	Time in minutes	Temperature [degrees F.]
With safelight only		
1 Developer	7	67-69
2 Stop-fix	3	67-69
Room lights may be turned on		
3 Wash	5	57-68
4 Bleach-fix	8	64-68

Agfacolor long process [*continued*]

Processing steps	Time in minutes	Temperature [degrees F.]
5 Wash	10	57-68
6 Bleaching bath	5	64-68
7 Wash	5	57-68
8 Buffer	5	64-68
9 Wash	5	57-68
10 Antifade	5	64-68
11 Drying		
Total time [not including drying]	58	

Agfacolor short process

This process also is intended for making Agfacolor prints from Agfacolor negatives but can be used for printing other makes of color-negative film, too. It is planned for use in professional darkrooms where high output is essential. Because of a high content of formaldehyde in the stabilizer bath, *this process should only be used in a well-ventilated darkroom.* It differs from the Agfacolor long process in that only four processing solutions are required: Agfacolor developer, stop-fix, bleach-fix, and formaldehyde stabilizer.

Processing steps	Time in minutes	Temperature [degrees F.]
With safelight only		
1 Developer	5	68 [within 1/2 degree]
2 Rinse	1-2 1/2	57-68
3 Stop-fix	5	64-68
Room lights may be turned on		
4 Rinse	1	57-68
5 Bleach-fix	5	64-68
6 Wash	10	57-68
7 Formaldehyde stabilizer	5	64-68
8 Drying		
Total time [not including drying]	about 32	

FR PK-17 process

This process is intended for making prints on Professional Color Enlarging Paper from color negatives.

Processing steps	Time in minutes	Temperature [degrees F.]
With safelight only		
1 Developer	5*	70 [within 1/2 degree]
2 Fix	1	68-75
Room lights may be turned on after fixing		
3 Wash	3	68-75
4 Bleach	2	68-75
5 Wash	5	68-75
6 Stabilizer	2	68-75
7 Drying		
Total time [not including drying]	18	

*Includes 10 seconds for draining print before fixing.

Kodak color-print process P-122

This process is primarily intended for making prints on Ektacolor Professional [formerly called Type C] paper from Kodacolor and Ektacolor negatives, but also can be used with other color-negative films.

You'll need a supply of Ektacolor Professional paper, a basic set of six red, six magenta, and six yellow CC filters, a Wratten No. 2B filter, and seven chemicals: developer, stop bath, fixer, bleach, hardener-fixer, hardener, and buffer. A Kodak Wratten No. 10 safelight can be used during printing exposure and processing.

Processing chemicals are available in kit form and individually.

Processing steps	Time in minutes	Temperature [degrees F.]
With safelight only		
1 Developer	12	75 [within 1/2 degree]

Kodak color-print process P-122 [*continued*]

Processing steps	Time in minutes	Temperature [degrees F.]
2 Stop bath	2	73-77
3 Fix	2	73-77
Room lights may be turned on		
4 Wash	2	73-77
5 Bleach	4	73-77
6 Wash	2	73-77
7 Hardener-fix	2	73-77
8 Wash	8	73-77
9 Hardener	3	73-77
10 Wash	2	73-77
11 Buffer	3	73-77
12 Drying		
Total time [not including drying]	42	

Color prints from color transparencies

Ansco Printon [Anscochrome Type]

This process is for making color prints on Ansco Printon from all color-transparency films. Eight processing chemicals are required: developer, first stop bath, color developer, second stop bath, hardener, bleach, fixer, and stabilizer. A basic set of filters required for this process includes one UV 16P, seven cyan, seven magenta, and seven yellow. The first two steps require *total darkness*–no safelight filter can be used.

Processing steps	Time in minutes	Temperature [degrees F.]
In total darkness		
1 First developer	9 1/2	75 [within 1/2 degree]
2 First stop bath	2	73-77

Ansco Printon [Anscochrome Type] [*continued*]

Processing steps	Time in minutes	Temperature [degrees F.]
Room lights may be turned on		
3 Wash	5	73-77
4 Reversal exposure [1/2 minute on each side with a 500-watt photoflood]		
5 Color developer	10	75 [within 1/2 degree]
6 Second stop bath	1	73-77
7 Hardener	3	73-77
8 Wash	5	73-77
9 Bleach	5	73-77
10 Wash	5	73-77
11 Fix	4	73-77
12 Wash	10	73-77
13 Stabilizer	2	73-77
14 Rinse	1/6	73-77
15 Drying		
Total time [not including drying]	about 62	

Kodak color-print process P-111

This process can be used for making color prints on Kodak Ektachrome paper from any color-transparency film. Seven chemicals are required: developer, stop bath, color developer, hardener-stop bath, bleach, hardener-fixer, and stabilizer. The basic filters include one Kodak Infrared Cut-Off Filter No. 301, one Wratten No. 2E, plus six cyan, six magenta, and six yellow. Total darkness is required for the first three steps.

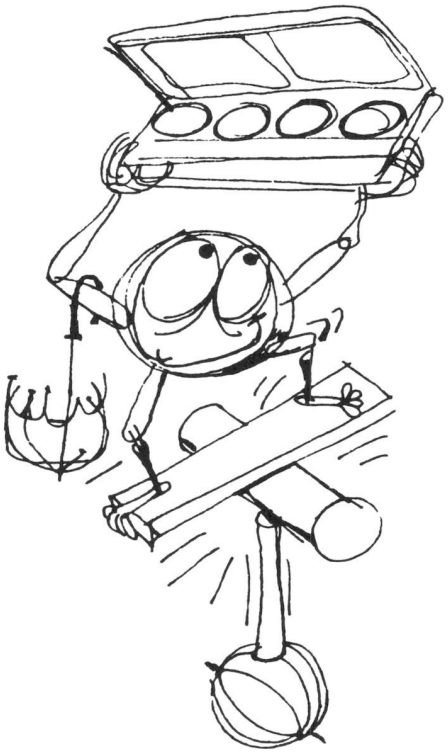
Kodak color-print process P-111 [*continued*]

Processing steps	Time in minutes	Temperature [degrees F.]
In total darkness		
1 Prewet	3	73-77
2 First developer	6	75 [within 1/2 degree]
3 First stop bath	4	73-77
Room lights may be turned on		
4 Wash	12	73-77
5 Reversal exposure [give emulsion side of paper a 15-second exposure to a 500-watt photoflood 1 foot distant]		
6 Color developer	8	75 [within 1/2 degree]
7 Hardener-stop bath	8	73-77
8 Wash	3	73-77
9 Bleach	8	73-77
10 Wash	6	73-77
11 Hardener-fixing bath	7	73-77
12 Wash	10	73-77
13 Stabilizing bath	1	73-77
14 Rinse	1/4	73-77
15 Drying		
Total time [not including drying]	about 77	

Drying and mounting color prints

In general, you can dry color prints much the way you do black-and-white ones. Just be sure that any blotters or towels used to remove excess moisture from the prints are clean and free from chemicals. If you use heat to dry the prints, keep the temperature below the maximum recommended by the manufacturer.

Rubber cement, glue, and paste are *not* recommended for mounting color prints because they may eventually cause the prints to fade. Use dry-mounting tissue. The print can be mounted with the aid of an electrically heated dry-mounting press or by using an electric iron and the method demonstrated in the lesson on professional procedures. Again, don't exceed the temperature recommended by the paper manufacturer.



The use of filters in color printing

To control the colors in your print, you need to know how to select the right combination of filters. You can use filters to correct the color so that it is as natural-looking and faithful to the subject as possible, or you can distort the colors for interpretive purposes. This freedom to alter and manipulate colors is a great advantage you gain in making your own color prints.

Before discussing the methods of combining filters to control color, let's first consider some specific reasons why you may need to use filters to get good results.

1 Adjusting for the color quality of the enlarger light: This light can vary from warmer to cooler, depending on the line voltage, as we have mentioned. Thus you may need to filter out the excess red if the voltage is too low, or the excess blue if the voltage is too high.

2 Adjusting for the color quality of your enlarger's optical system: Different makes of enlargers may produce prints with different color quality due to variations in the color of the condenser lenses, the color-transmitting quality of the enlarger lens, the color of the paint used on the reflecting surface inside the lamphouse, etc. The only way to learn what combination of filters will produce the best results with any enlarger is actually to work with it until you are familiar with its characteristics.

3 Adjusting for differences in color-printing paper: Each batch of color paper [designated by an *emulsion number*] can have somewhat different color balance. To adjust for this you may need to add or take away a filter or filters from the filter pack you are using.

4 Adjusting the color to suit your own taste: The color quality that seems "best" or "most natural" may vary with the photographer. For example, a print that appears pleasing and natural to one person may look slightly too greenish or yellowish or too much on the magenta side for another. Filters enable you to adjust the colors in the print to suit *your* taste.

Filters for negative-to-positive color printing

When making a color print from a color negative, a basic rule to follow is this: To remove a particular color from the print, *add a filter of the same color* to the filter pack or *remove a filter of its complementary color*. The following chart sums this up.

If a test print has too much of this color	Add a CC or CP filter of this color	Or remove one of this color
red	red [R]	cyan [C]
blue	blue [B]	yellow [Y]

Filters for negative-to-positive color printing [*continued*]

If a test print has too much of this color	Add a CC or CP filter of this color	Or remove one of this color
green	green [G]	magenta [M]
yellow	yellow [Y]	blue [B]
magenta	magenta [M]	green [G]
cyan	cyan [C]	red [R]

You'll probably need to make a number of tries, changing the filters and exposures until you get the result you want. As you gain experience with your equipment and the color process you are using, you'll probably be able to start with a filter pack that is somewhere near correct, or at least be able to correct any gross errors in exposure and/or color after making your first test print.

Once you're on the right track, you need to make more refined judgments. A method used by many color workers is to examine a test print–it needs to be one that's approximately right–through a number of filters, singly or in combination, until they find a filter or filters that make the colors in the print look right. [We'll call these the *viewing filters.*] In using this method, study the lighter middle tones–they are your best guide. Also, be sure the viewing light is similar in strength and color quality to the light you expect to use for viewing the final print.

When you find a filter or combination of filters that makes the print look right, follow this procedure:

1. If possible, *remove a filter of the same color as the viewing filter* so that you are using the smallest number of filters needed for the effect you want.
2. If you can't proceed as suggested in Step 1, *add a filter of complementary color to the viewing filter.*

The filter you remove or add should have *half the density value of the viewing filter.* For example, if the print looks best through a 20R filter, remove a 10R filter or add a 10C filter [cyan being the complement of red]. If the print looks best through a combination of 20Y plus 20C filters, you should remove a 10Y plus 10C or add a 10B plus 10R.

To make it easier for you to work with filters in color printing, memorize these complementary pairs of colors:

red–cyan
blue–yellow
green–magenta

Determining the best filter combination

In putting together the necessary CC or CP filters for your filter pack, you should use the simplest combination possible–that is, the combination that gives you the color effect you want with the fewest filters and the smallest amount of density. With CC filters under the lens, *you shouldn't use more than three filters in your filter pack.*

The manufacturers of different color filters provide directions and tables for

finding the simplest combination. Particularly useful for Kodak CC and CP filters are the filter tables and computers in the Kodak Color Dataguide. However, here we give you some general advice that can help you work out the necessary calculations yourself.

First, let's review some basic characteristics of light. White light is composed of red, green, and blue light. These are the *additive primary colors of light.* The complements of these additive primaries are cyan, magenta, and yellow respectively. These are sometimes called the *subtractive primaries* because each one represents white light minus one of the additive primaries.

For example, magenta is white light minus green [leaving a mixture of red and blue], cyan is white light minus red [leaving blue and green], and yellow is white light minus blue [leaving red and green.]

To determine the simplest combination of filters for use in color printing, it is helpful to *convert all filters to their equivalent in subtractive colors,* if they aren't already subtractive colors.

To do this readily, memorize the following table:

A *red* filter = a *yellow* filter + a *magenta* filter
A *green* filter = a *yellow* filter + a *cyan* filter
A *blue* filter = a *magenta* filter + a *cyan* filter

Another way to think of it is that any additive primary is equal to the two subtractive primaries which aren't its complement.

Let's take some examples. A 20R [red] filter equals a 20Y [yellow] plus a 20M [magenta]. Notice that each filter in the subtractive pair has the same density value as the additive color filter. That is, the combination is 20Y plus 20M, *not* 10Y plus 10M. A 10G equals a 10Y plus a 10C, a 40B equals a 40M plus a 40C, etc.

You need to know two more basic rules, and then we'll work out a practical problem to show how they operate.

The first rule: When combining or removing filters *of the same color,* add or subtract their density values in the normal way. For example, a 20M plus a 10M equals a 30M filter, a 20Y minus a 10Y equals a 10Y, etc.

The second rule is a bit more complicated. When a filter pack contains *all three* subtractive primaries–cyan, magenta, and yellow–subtract the density value of the weakest filter from all three. For example, 10C plus 20M plus 20Y equals 10M plus 10Y [a value of 10 having been subtracted from all three]. What you are removing is something called *neutral density.* This is density that reduces the amount of light reaching the printing paper but has no effect on the colors.

Removing any neutral density is an important step in simplifying a filter pack, so let's try another example. How would you remove the neutral density from a filter pack containing a 40C plus 30M plus 20Y? The value of the weakest of the three subtractives is 20. Subtract 20 from 40C, 30M, and 20Y. The result is 20C plus 10M. This combination of two filters will give you the same color effect but with 0.20 less density.

Now let's assume you make a test print with a 30M and 20R filter pack. It looks best when you view it through a 20Y plus a 20G filter. What combination of filters should you use in making the final print? [Working out the answer to this question is complicated, but it illustrates just about all the common problems you are likely to encounter.]

First, convert your original filter pack into subtractive primaries. 20R

equals 20Y plus 20M. [The 30M already is a subtractive color.] You might jot down something like this:

$$\begin{array}{r} 20\text{R} = 20\text{M} + 20\text{Y} \\ \underline{\quad 30\text{M} \quad} \\ 50\text{M} + 20\text{Y} \end{array}$$

We have said that a 20Y plus 20G gave the best viewing results. Remember –you add filters that are complementary in color to your viewing filters, but that have half the density. Blue is the complement of yellow, and magenta is the complement of green. Therefore you should add a 10B plus 10M to your filter pack to give the desired correction.

However, 10B plus 10M must be converted into subtractive primaries. Change blue–an additive primary–into its equivalent subtractive pair: 10C plus 10M. Add the 10M you already have. Your final result: 20M plus 10C.

Now write out the values for the filters in the filter pack and for the new filters. Add up the total values of filters of the same colors, like this:

50M	20Y		[your original filter pack converted to subtractive primaries]
20M		10C	[the filters you want to add, converted to subtractive primaries]
70M	20Y	10C	

Don't stop yet. You have all three subtractive primaries in this filter pack. That means there's some neutral density to get rid of. The value of the weakest filter [10C] is 10. Therefore, subtract 10 from all three filters.

The result: 60M plus 10Y.

The problem now is that 50M is the greatest density available in a single CC filter. You could combine three filters to get the desired effect–50M plus 10M plus 10Y. But there's a simpler solution.

The left-over 10M plus 10Y equals 10R. [Remember that red equals yellow plus magenta.]

Therefore, the simplest combination to get the effect you want is this: 50M plus 10R. This is the filter pack you should use in making your final print.

When you add or take away filters from a filter pack, you also may change the exposure. Different manufacturers give different methods for compensating for exposure changes, and it's best to follow their instructions. [The Kodak Color Dataguide can be very helpful in determining the exposures needed when using Ektacolor paper. The guide contains charts and calculator dials that simplify the necessary computations.] However, here are some rough rules of thumb that color workers sometimes use:

Each filter you add or take away, regardless of color, affects exposure 10 percent.

In addition, add or subtract the following:

10 percent for each 0.10 density change of cyan
5 percent for each 0.10 density change of magenta
2 percent for each 0.10 density change of yellow

For example, suppose you know the exposure for a print made through a 20Y and a 10M filter. To correct the color, you find you need to change to a 10Y and a 25M filter pack. How does this affect exposure?

Your new pack contains 0.10 less yellow density [10Y rather than 20Y]. This reduces the needed exposure 2 percent. But it contains 0.15 more magenta density [25M instead of 10M]. This requires an exposure increase of about 7 percent. To get the 25M you combine a 20M and a 5M filter. You now have three filters in the pack instead of just two, so add 10 percent for the additional filter. Now total up all the required changes [−2, +7, and +10]. Your new exposure needs to be about 15 percent more than the old.

Filters for positive-to-positive color printing

In making color prints by the positive-to-positive method [from a color transparency rather than a color negative], you will find the following table helpful:

Correction table

If print is too	Add filter[s] of this color	Or subtract filter[s] of this color
yellow	blue or magenta + cyan	yellow
magenta	green or yellow + cyan	magenta
cyan	red or yellow + magenta	cyan
blue	yellow	blue or magenta + cyan
green	magenta	green or yellow + cyan
red	cyan	red or yellow + magenta

In practice, the method of determining the correct filtration is much the same with the positive-to-positive method as it is when working with color negatives. You make a test print and view it through a number of filters or filter combinations until the colors look right. In this case, however, *you add a filter of the same color as the viewing filter or subtract a filter of complementary color*. It's opposite to what you'd do with a color negative.

Evaluating color test prints

A vital aspect of making a good color print is your ability to evaluate the colors in a test print and decide what you need to add or take away to get the color effect you want. This is a skill you can only acquire by experience. However, the following pointers can help you develop this skill more quickly.

1. Choose one color process and work with it until you are thoroughly familiar with it.
2. Be sure to read and follow the manufacturer's advice regarding the recommended procedure for making a test print and evaluating it. Use any charts or tables supplied by the manufacturer–they often can save you much time in computing filter combinations, calculating exposure, etc.
3. Standardize your working procedure so you can repeat good results.
4. Keep notes of filters and exposures used. Jot them down on the back of test and final prints. This information can be a big help when you make more prints later on.

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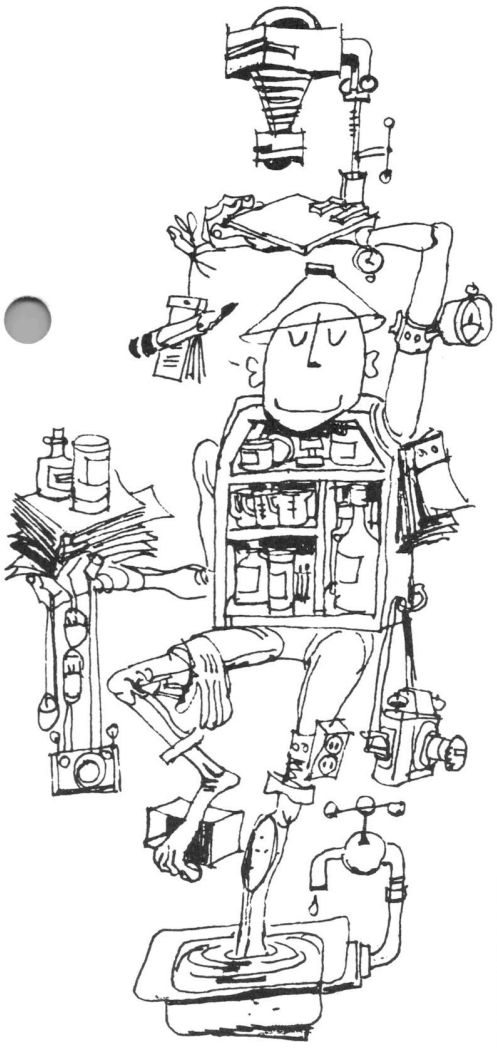
Miscellaneous items of special interest



In this section we've covered a number of miscellaneous items of special interest, including a list of films for copying, how to test color film, a table of weights and measures commonly used in photography, and other items. From time to time you may want to enlarge this section by adding other useful material–data sheets or instructional material from manufacturers; charts, tables, and technical articles from photographic publications, etc. Just punch holes in the sheets you want to save and insert them in this book, using the ring binders.

Films for copying

Following are two charts–one of films especially suitable for continuous-tone copying [photographs, toned art work, etc.] and one of high-contrast films designed for copying line drawings, printed type, etc.

Continuous-tone films

Although just about any slow or medium-speed film can be used for continuous-tone copying, the ones we've listed here are especially designed for this purpose. [Some of these also are excellent for line copying, too. See the following chart.] The numbers in brackets are suggested exposure indexes to use for making test exposures when copying by floodlight illumination. Be sure to read and follow the film manufacturer's instructions carefully–in most cases, special processing methods are recommended.

Manufacturer	35 mm	Sheet film
Ansco		Commercial Ortho* [25]
Du Pont		Cronar Commercial-S** [50]

*Orthochromatic
**Blue sensitive

Continuous-tone films [*continued*]

Manufacturer	35 mm	Sheet film
Kodak		Commercial** [16]
		Commercial Ortho* [25]
	Fine Grain Positive** [0.3]	Fine Grain Positive** [0.3]
		Gravure Copy* [12]

*Orthochromatic
**Blue sensitive

Line-copying films

Special high-contrast films such as the ones listed here are recommended for line-copying work. However, no special high-contrast films are supplied in roll-film sizes. If you must use a roll-film camera, choose a slow, very fine-grain film and process in a high-contrast developer such as a paper developer. The numbers in brackets are suggested exposure indexes to use for making test exposures when copying by floodlight illumination. The films listed are panchromatic unless otherwise indicated.

Manufacturer	35 mm	Sheet film
Adox	Doku-Pan [10]	
Agfa	Agepan [64]	
	Agepan FF* [12]	
Ansco		Reproline* [5]
		Reprolith** [1.6]
		Reprolith Ortho* [2.5]
		Reprolith Ortho Type B* [5]
		Reprolith Ortho Type C* [8]
		Reprolith Pan [12]
Du Pont		Cronar Commercial-S** [50]

*Orthochromatic
**Blue sensitive

Line-copying films [*continued*]

Manufacturer	35 mm	Sheet film
Kodak		Contrast Process Ortho* [50]
		Contrast Process Panchromatic [80]
	Fine Grain Positive** [10]	Fine Grain Positive** [10]
	High Contrast Copy [64]	
		Kodalith Ortho* [6]

*Orthochromatic
**Blue sensitive

How to make color film tests

In professional color photography–such as portraiture, advertising, or fashion –it's often desirable to make test exposures with your color film before shooting the final pictures. The reason is that many factors can affect the quality of a color picture. The best way to be certain you will get the result you want is to check things out beforehand.

Following is a good procedure to use when you want to make a color test.

First, shoot your test on film that has the same *emulsion number* as the film you will use for the final shooting [all film from a particular run is coded with the same number]. This calls for some explanation.

Variations in speed and color quality may occur between different runs or batches of color film during its manufacture. One batch of film may be somewhat faster or slower, and it also may tend to produce results a little more on the warm or cool side than usual.

Reputable film manufacturers maintain strict quality control, and release a run of film for sale only when it stays within fairly narrow limits of the standard for that film. For the average amateur user, the slight variations in speed and color quality usually are not too important. But as an aid to professional workers, some color films are identified by emulsion number. A supplementary data sheet giving special exposure and filter recommendations for that particular batch of film may also be included in the film package.

The advantage of using a quantity of film of the same emulsion number is that once you have made your exposure and color tests, the results will apply to all film of that same emulsion number when exposure conditions are the same as for the test [assuming proper storage of unexposed film and standardized processing]. Bear in mind, we are talking about very exact professional work here, where precise color and exposure control are important.

What many professionals do is buy their film in quantity, purchasing a large enough supply of one emulsion number to last them for weeks or even months. If you decide to buy film in quantity, keep in mind these two important points:

It should be used before the expiration date stamped on the package and *it should be stored under conditions recommended by the manufacturer.*

Unopened packages of film can be safely stored for several months in the main compartment of a refrigerator at about 45 to 55 degrees F. Open a small quantity at a time and use as needed. [Film should be warmed to room temperature before use.]

To carry out an effective test, you must standardize your procedure and duplicate as closely as possible the conditions under which you will take the final picture. Use the same subject, or a similar stand-in subject. In portraiture, use a person of normal complexion. Use the same camera, lens, and lighting equipment you will use for the final shots. Make a record of the number of lights, their position, and their distance from the subject [or even mark their position on the floor]. Then you can easily re-create the same lighting setup again.

If there is a supplementary data sheet with your film, read that and follow the manufacturer's recommendation regarding the exposure index to use and any filters that may be required for most accurate color.

A good way to take exposure readings for a test is with a gray card, because this method helps standardize the procedure. A standard gray card [such as the one included in the Kodak Color Dataguide] is easy to use indoors or outdoors. Hold the card close to and in front of the subject, facing halfway between the camera and the mainlight [indoors] or the camera and the sun [outdoors]. Take a reflected-light meter reading, with the meter not more than six inches away. [Be careful the shadow of your hand or meter doesn't fall on the card.]

Now set your exposure. Give one-half more exposure than the gray-card reading indicates. Bracket this basic exposure with additional exposures at half-stop intervals. Make exposures from two stops under to two stops over. [When shooting a series of test shots, it's a good idea to open up your lens to its widest aperture and then stop down to the *f* stop you want *each time you change the aperture setting*. This reduces the possibility of error caused by the overlapping leaves of the diaphragm being too loose or too tight.]

Keep a record of your exposures. A good way to do this is to mark the exposure on a card and include the card in the picture. Then there's no possibility of getting the pictures mixed up.

If the result of your first test is unsatisfactory in terms of color, make a second test, experimenting with CC filters. With experience, you can learn to judge pretty accurately by eye what color filter and what strength is needed. If in doubt, try several filters to see which produces the best results.

Be sure to view your test color pictures under the same lighting conditions each time with lighting similar in intensity and color quality to the light you plan to use for the final pictures. For example, if you hold a transparency up to a window on a rainy day, the colors in it will look much bluer than they would if you held the same transparency up to tungsten light. A good light box can provide you with a standard light for studying test color transparencies. [Instructions for making a light box are included in our section on things to make.]

Finally, the test film *must receive exactly the same processing as will be used for the final pictures.* Use a reliable processing lab–one that has given you consistently good results in the past, or process the film yourself, following the manufacturer's directions exactly.

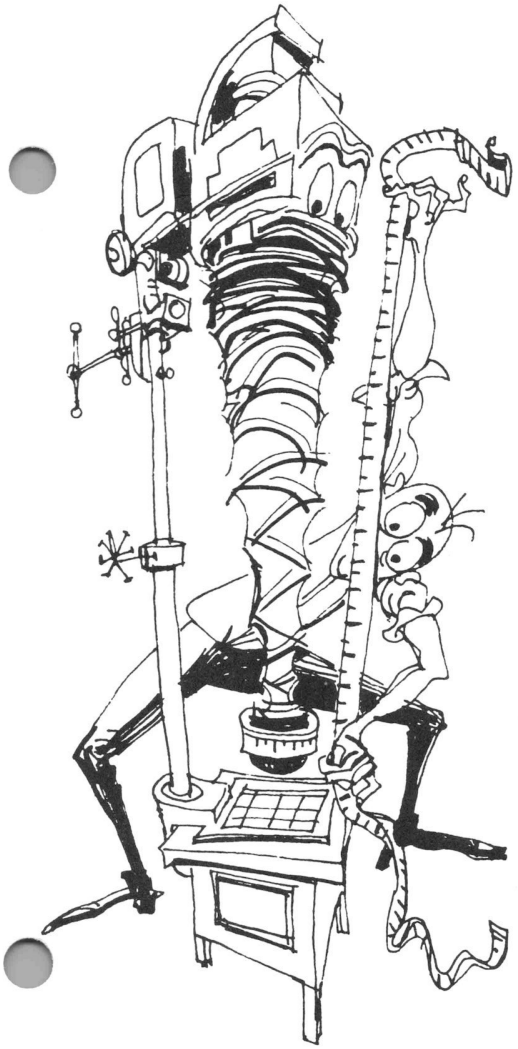
Reciprocity failure and color shift due to long exposure

Information regarding reciprocity failure for a particular emulsion number of film may be included with the supplementary data sheet supplied with some professional color films. Also, this sheet may give recommendations for the filter or filters needed to compensate for any shift in the color balance of the film that may occur at longer than normal exposures.

However, these recommendations are guides only and not a substitute for a test made by the photographer under his own working conditions. If the assignment is important, and exact control of the color is necessary, shoot a test first and study the results. Then adjust the exposure and add filters if necessary before you shoot the final picture.

For black-and-white films, the following table can be used as a rough guide for test purposes.

Slow pan film		Medium pan film	
Indicated exposure	Reciprocity factor	Indicated exposure	Reciprocity factor
10 seconds	2x	10 seconds	2.2x
20 seconds	2.2x	20 seconds	4x
30 seconds	4x	30 seconds	6x



Calculating exposure change due to lens extension

Here is a way to calculate any required exposure increase due to bellows extension:

1. Measure the lens-to-film distance.
2. Convert the lens-to-film distance and the focal length of the lens to the same unit of measurement–inches, millimeters, or centimeters [whichever is more convenient].
3. Multiply the lens-to-film distance by itself.
4. Multiply the focal length by itself.
5. Divide the result of step 3 by step 4.
6. The number you get is a factor which tells you how much your exposure must be increased.

Written as a formula, the procedure is this:

$$\frac{\text{Total lens extension}^2}{\text{Focal length}^2} = \text{Factor by which exposure must be multiplied}$$

For example, assume you have a 2-inch lens on your camera, and the total extension [lens-to-film distance] is 4 inches:

$$\frac{4\text{x}4}{2\text{x}2} = \frac{16}{4} = 4$$

Thus, your exposure must be increased four times. For instance, if the indicated exposure is 1/60 second at *f*/8, you'd need to open the diaphragm two full stops to *f*/4 or reduce the shutter speed to 1/15 second.

Photographic weights and measurements

The following tables give equivalent weights and measures often useful in photography.

Linear measurements

1 inch = 2.54 centimeters or 25.4 millimeters
1 millimeter = 0.0394 inches
1 centimeter = 0.394 inches

Weighing and measuring solids and liquids

In American photographic practice, solids are weighed either by the avoirdupois or the metric system, and liquids are measured by the U.S. liquid or the metric system. The following tables give the equivalent values for converting photographic formulas from one system to another.

Converting avoirdupois to metric weight

Pounds	Ounces	Grains	Grams	Kilograms
1	16	7,000	453.6	0.4536
0.0625	1	437.5	28.35	0.02835
		1	0.0648	
	0.03527	15.43	1	0.001
2.205	35.27	15,430	1,000	1

Converting U. S. liquid to metric measure

Gallons	Quarts	Ounces [fluid]	Drams [fluid]	Cubic centimeters	Liters
1	4	128	1,024	3,785	3.785
0.25	1	32	256	946.3	0.9463
		1	8	29.57	0.02957
		0.125	1 [60 mins.]	3.697	0.003697
		0.03381	0.2705	1	0.001
0.2642	1.057	33.81	270.5	1,000	1

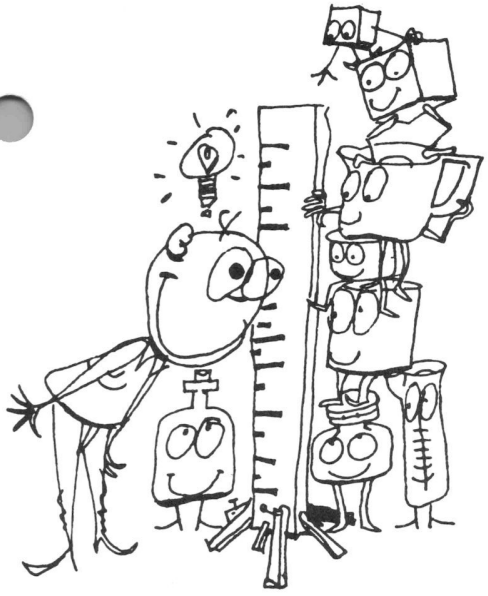
Conversion factors

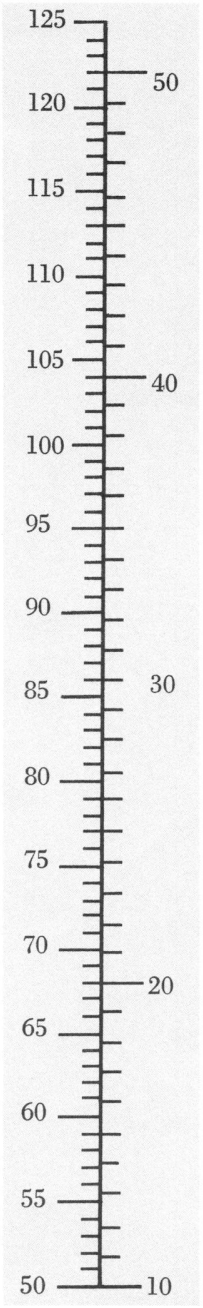
Grains per 32 fluid ounces	× 0.06847	= grams per liter
Ounces per 32 fluid ounces	× 29.96	= grams per liter
Pounds per 32 fluid ounces	× 479.3	= grams per liter
Grams per liter	× 14.60	= grains per 32 fluid ounces
Grams per liter	× 0.03338	= ounces per 32 fluid ounces
Grams per liter	× 0.002086	= pounds per 32 fluid ounces
Grams per liter [approx.]		= ounces per 30 quarts
Grams per liter [approx.]		= pounds per 120 gallons
Ounces [fluid] per 32 ounces	× 31.25	= cubic centimeters per liter
Cubic centimeters per liter	× 0.032	= ounces [fluid] per 32 ounces

Centimeters × .394 = inches

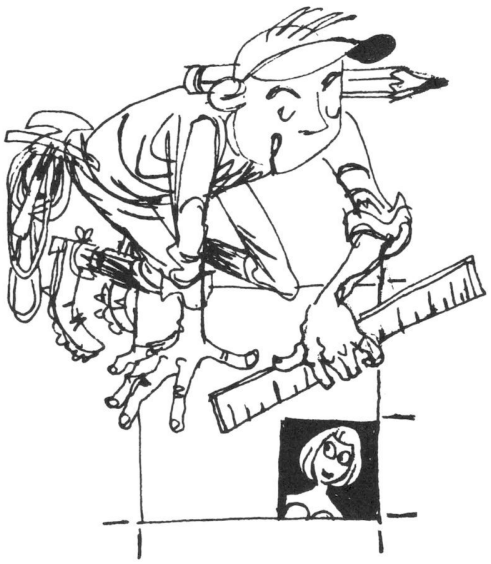
Inches × 2.54 = centimeters

Temperature conversion scale
Fahrenheit [F] to Centigrade [C]





How to copy a drawing to scale



In taking pictures with a camera having a groundglass back, it sometimes may be helpful or necessary to copy a sketch to exact size on a sheet of tracing paper or transparent acetate which you attach to the groundglass as a guide in composing the picture. For example, in an advertising picture you might want to position your subject exactly to allow space for type which will be added later. One way to do this is to make your sketches exactly to size, trace them, and attach the tracing to the groundglass with masking tape. However, sometimes your sketch may be larger or smaller than the size of your film. You'll need to "scale it down" or "scale it up"–that is, change its size so it fits your film, but keep exactly the same proportions.

To do this neatly and efficiently you need a T-square and a plastic triangle. Use a medium pencil for tracing paper [not too soft or it will smudge] or a grease pencil for acetate.

First, line up the paper or acetate with the edges of your drawing board and tape the paper or acetate down so it won't slip. Using your T-square and triangle to help you make straight sides and exact right angles, mark the exact dimensions of your groundglass. Now draw an inner frame that is slightly smaller than the groundglass dimensions. Allow about a quarter of an inch margin for 4x5 and up to about an inch for 8x10. We'll call this the *safety frame* because it allows you a little margin for error around the edges. You should keep the picture within the safety frame.

Let's suppose the sketch you're using is larger than the groundglass and the picture is a narrow horizontal. Your next step is to make a matching but scaled-down copy of the sketch on your tracing paper or acetate sheet as follows.

Slip the sketch under the tracing paper or acetate. Exactly line up the upper left corner of the sketch with the upper left corner of the safety frame. Now lightly draw a diagonal line from the upper left corner of the sketch to the lower right corner of the sketch, as shown in Diagram A.

At the point where this diagonal cuts across the right border of the safety frame, draw a new horizontal line, as shown in Diagram B. The shaded area indicates the area within which you should compose your picture to keep the proportions of the picture the same as they are in the sketch.

Now remove the sketch and copy it in reduced size to fit within the boundaries you have marked on your tracing paper or acetate. You don't need to make a detailed drawing, of course. Just indicate in outline the position of the subject and any other important elements.

As an aid in copying, try this. Divide the original sketch into nine equal rectangles by making a "grid" with two vertical and two horizontal lines, as shown in Diagram C. Now do the same with the safety frame on your tracing paper or acetate. By copying just one rectangle at a time you should find it much easier to do an accurate job.

Diagram A

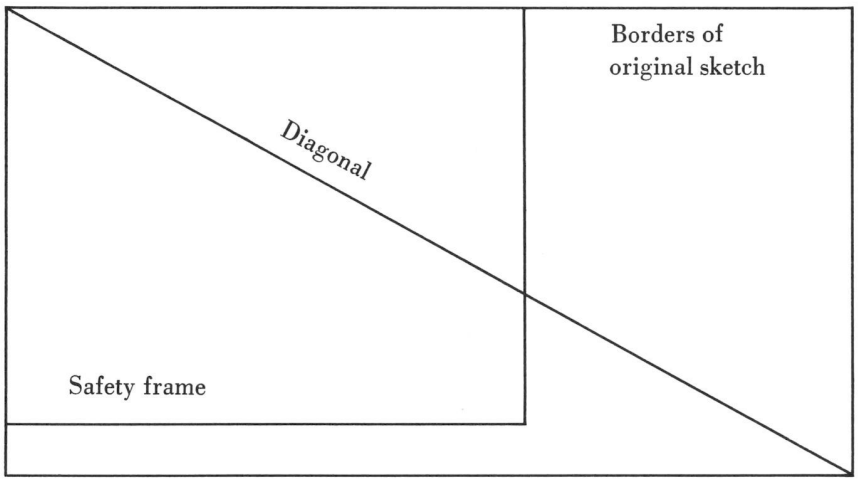


Diagram B

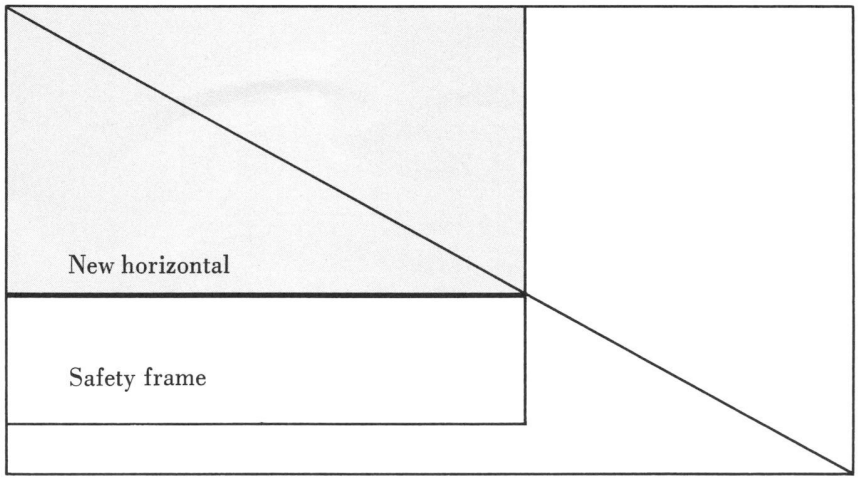
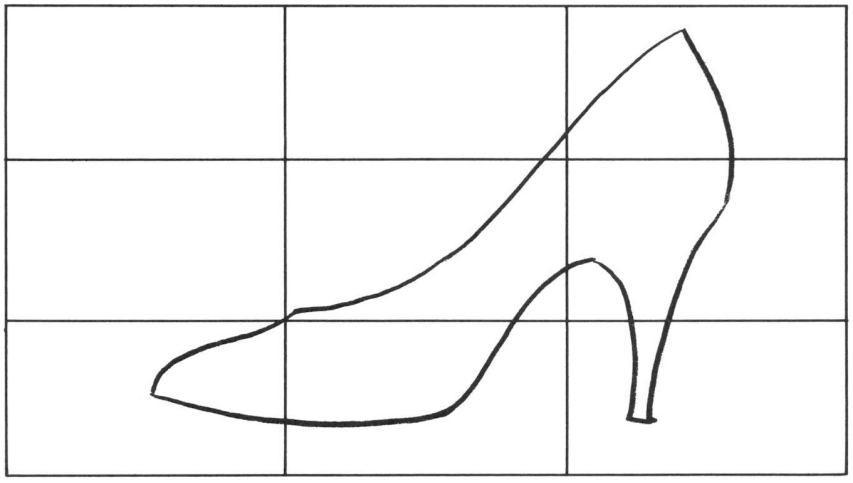
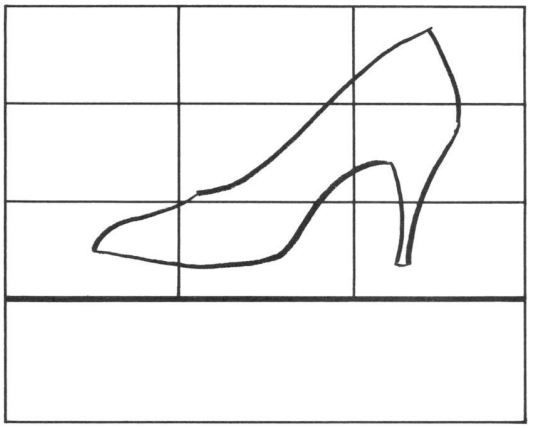


Diagram C Original sketch



Tracing or acetate



Super-proportional reducer

The purpose of a super-proportional reducer is to reduce highlight density without removing shadow detail. It's most useful in treating overdeveloped negatives of contrasty subjects. The following Kodak formula gives this type of reducer.

Kodak Persulfate Reducer R-15

Stock solution A	U. S. liquid or Avoirdupois	Metric
Water	32 ounces	1.0 liter
Potassium persulfate	1 ounce	30.0 grams
Stock solution B		
Water	8 ounces	250 cc
*Sulfuric acid [dilute solution]	1/2 ounce	15 cc
Water to make	16 ounces	500 cc

*To make, take 1 part of concentrated sulfuric acid and, with caution to avoid contact with the skin, add it slowly to 9 parts of water stirring all the while. Never add the water to the acid–the solution may boil and spatter the acid on the hands or face, causing serious burns.

For use: Take 2 parts of Solution A, and add 1 part of Solution B. Only glass, hard-rubber, or impervious and unchipped enamelware should be used to contain the reducer solution during mixing and use.

Treat the negative in the Kodak Special Hardener SH-1 for 3 minutes and wash thoroughly before reduction. Immerse in the reducer with frequent agitation and inspection [accurate control by time is not possible] and treat until the required reduction is almost attained; then remove from the solution, immerse in an acid fixing bath for a few minutes, and wash thoroughly before drying. Used solutions do not keep well and should be promptly discarded.

For best keeping, the persulfate Stock Solution A should be stored away from excessive heat and light. Storage life of Stock Solution A is about 2 months at 75 degrees F. [24 degrees C.].
[Formula courtesy Eastman Kodak Co.]

Infrared photography

Infrared means "beyond red," and refers to the radiation similar to light that occurs beyond the red end of the color spectrum. Although infrared radiation is invisible to the human eye, it can be used to record an image on special infrared film just as visible light rays can produce an image on ordinary film.

Fascinating effects are possible with these special infrared films and a dark red filter. In landscapes, the sky is rendered jet black, green foliage comes out almost white, and distant details are recorded with startling clarity. Outdoor scenes taken by infrared and printed a little darker than normal strongly suggest they were made by moonlight. Flash pictures can be made on infrared film, too. The dull red flash of a special infrared flashbulb throws no visible light on the subject, but exposes the infrared film. Thus it is possible to take candid flash photographs without the subject being aware of it.

When shooting outdoors, you must use a dark red filter on the lens to get the full infrared effect. This is because infrared film also is sensitive to some visible light in the blue part of the spectrum. The purpose of the red filter is to filter out the visible light so your picture is made primarily by infrared radiation. [When using infrared flashbulbs in the dark you need no filter because only the flashbulb–which primarily emits invisible infrared radiation–is illuminating the scene.]

Infrared rays do not focus in the same plane as visible light rays do. To get a sharply focused picture, it's necessary to increase the lens-to-film distance to compensate for this difference between infrared radiation and visible light. Some lenses have a red dot on them that indicates the best setting for infrared pictures. Also, the lens manufacturer sometimes gives the necessary correction for infrared photography in the lens' data sheet. Otherwise, you'll need to make tests with your lens to determine how much you'll need to extend it. Try 1/4 of 1 per cent of its focal length as a starting point. For sharpest results with infrared photography use the smallest lens opening practical.

Exposure meters are primarily sensitive to visible light and therefore are not reliable guides to correct infrared exposure since the amount of infrared radiation in an outdoor scene can vary widely. Bracket your exposures or, if there's time, make a test exposure.

Infrared film is supplied by Kodak in the following types and sizes. The suggested exposures given below can be used as a basis for your own tests:

Kodak Infrared Sheet Film: With a No. 25 [A] filter, the suggested exposure for distant scenes in daylight is 1/25 second at *f*/5.6, and for nearby scenes is 1 second at *f*/16.

Kodak Infrared Film [35-mm size]: This is available on special order through Kodak dealers in 20-exposure loads and 50-foot rolls. With a No. 25 filter, the suggested exposure for distant scenes is 1/25 second at *f*/8 and for nearby scenes is 1 second at *f*/22.

Kodak High Speed Infrared Film: This is available in 100-foot rolls of 16-mm and 35-mm. With a No. 25 filter the suggested basic exposure is 1/25 second at *f*/16.

To take infrared flash pictures, a No. 5R or 22R infrared flashbulb is recommended, or you can cover the front of the flash reflector with a piece of gelatin such as the Kodak Wratten Gelatin Film Filter No. 87 or 87C and use white flashbulbs. The filter transmits only infrared radiation. Be sure it covers the reflector completely, with no light leaks. With this filter, a No. 5 or 25 flashbulb can be used with the same guide numbers as are given for No. 5R infrared flashbulbs without a filter. You also can convert an electronic flash unit to infrared photography by covering the reflector with an 87 or 87C filter. Make exposure tests to determine the correct guide number for your particular unit.

The biggest difficulty in shooting infrared flash pictures is that you'll be

working in the dark and therefore won't be able to focus and use your viewfinder in the normal way. Usually it's necessary to know ahead of time where your subject will be, set your camera up, aim and focus, and then calculate your flash exposure and set the exposure controls.

Processing infrared film is done in the normal way. The only precaution is that the film must be handled in total darkness, or you must use a light-proof tank or a Wratten Series 7 [infrared] filter. [With Highspeed Infrared film, use no safelight.] Other types of safelights are *not* safe with infrared film. On the other hand, a Series 7 [infrared] filter is *not safe* to use with ortho or pan films.

Complete processing instructions are included with the film data sheet. Just for example: Infrared Sheet film requires 8 minutes at 68 degrees F. in D-76, with tank developing; 35-mm infrared film requires 14 minutes at 68 degrees F. with full-strength Microdol-X; and the High Speed film requires 11 minutes in D-76 at 68 degrees F.

12

Things to make

If you have the money and desire, there's practically no limit to the amount of special equipment and accessories you can buy for photography. However, elaborate and expensive equipment by itself does not necessarily lead to good pictures. Throughout this Course we've emphasized the varied effects and good results you can get with a minimum of essential equipment. And from time to time we have shown you how to make certain items that can help you do a better job.

In this section we've included a number of other worthwhile projects–things to make for your studio, darkroom, and camera. Most are inexpensive and require relatively little skill or tools. In some cases you may prefer to have the work done by a carpenter or electrician under your direction. We have chosen items of practical value that enable you to save money by making them yourself rather than buying the items ready-made, or that require custom fitting to your own equipment.

Before starting to work on any of these projects, we suggest you read the directions carefully and study the photographs and diagrams until you understand them. Check the materials and parts list, when one is provided, to be sure you have all the things you need before you begin. Take your time and do a good job–if you construct these items carefully, they can have a long and useful life.

A three-outlet junction box with switch

This junction box can be very valuable in your studio or on location. You can plug its cable into any convenient electrical outlet and then attach up to three lights to the box itself. The box is provided with a switch so you can turn all the lights on or off simultaneously, which is much quicker and more convenient than working your lights individually.

This unit is intended for use with up to three 500-watt [No. 2] photofloods

–for a total of 1,500 watts and about 15 amps. *This is the maximum load you should put on an average household circuit. Do not overload a circuit by adding more lights or you may blow a fuse. Do not replace an existing fuse with one of higher load.* If you do this and overload the circuit you run the risk of starting a fire.

What you need

You'll need the following items [the electrical materials are available at most hardware or electrical supply houses]:

Two "handy boxes." [Get the surface-mounting type of the right size to hold a standard double outlet.]
Two double-outlet covers for the boxes.
One double outlet.
One combination toggle switch and single outlet.
Twenty-five feet [more or less, as you wish] of 14/2 rubber-insulated cable.
One 2-prong plug to fit this cable.
One connector of the Romex type [to securely clamp the end of the cable to one of the boxes].
Four 3/4-inch wood screws to attach the boxes to the plywood base.
One piece of 3/4-inch plywood measuring 5x6 inches as a base for the unit.

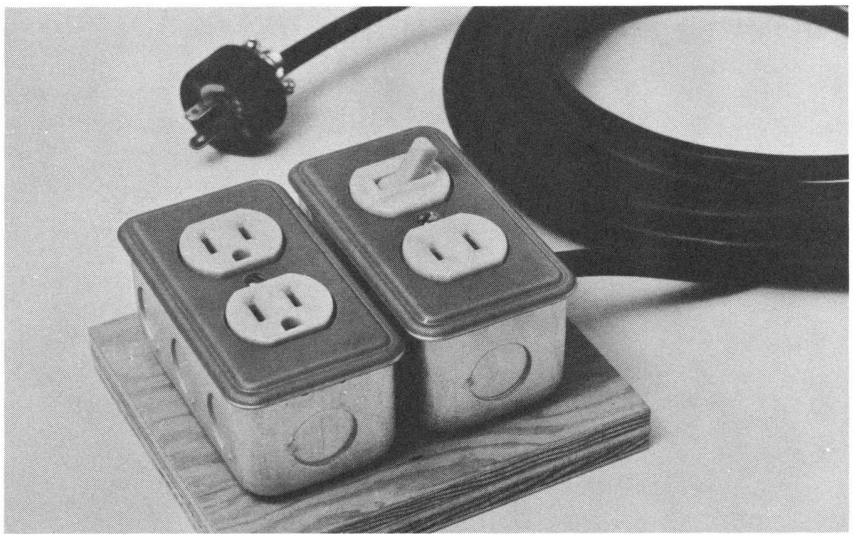
Making the box

Follow this procedure. Take one of the boxes and look at its long side. You'll see three circular plugs. Knock out the center plug. [A blow or two with a small hammer should do this easily.] Now knock out the center plug on the opposite side of the box. You'll use this box to hold the combination switch and single outlet. Knock out the center plug on *only one side* of the second box.

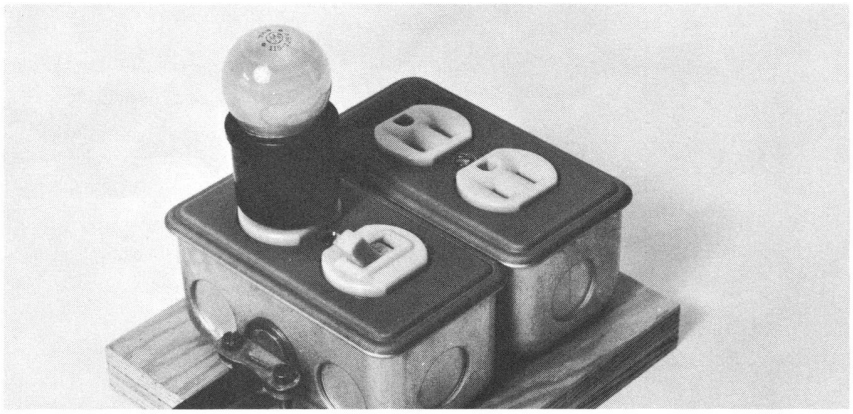
Screw the two boxes onto the plywood base. [There are holes in the bottom of each box for this purpose.] Two screws are enough to hold each box securely. The boxes should be lined up side by side, almost touching. Be sure the hole in the second box [where you knocked out just one plug] is on the inside, facing a corresponding hole in the first box so you can run connecting wires from one box to the other.

Cut off a foot or so of cable and remove the heavy outside insulation. The two wires you'll find within can be used to make the internal electrical connections, as we'll explain.

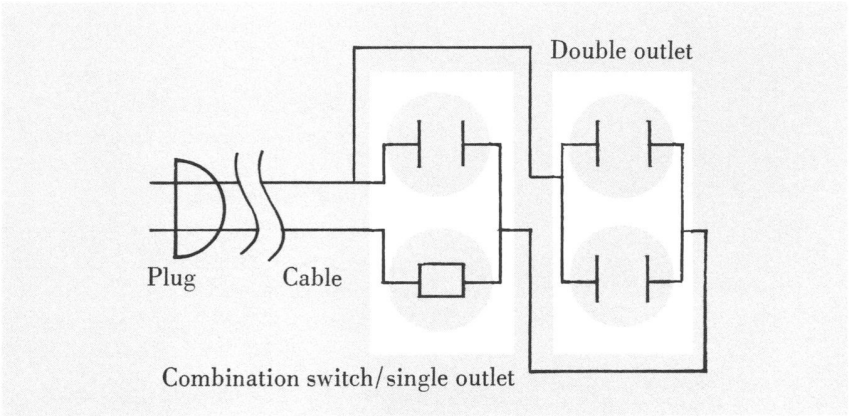
Attach the two-prong plug to one end of your long cable and attach the other end to the first box, using the connector to make a secure connection. The end of the cable should extend through the hole into the box. Cut off enough insulation to expose a half-inch or so of the two wires inside the cable. Connect these wires to the combination switch and outlet. Use short lengths of your extra wire to complete the electrical connections as shown in the accompanying wiring diagram. [The wire must run from one box to the other through the holes you have provided.] When you've completed the wiring, attach the outlets to the boxes and screw on the lids. [If you're doubtful about your ability to do the wiring yourself, an electrician can easily do it for you.]



Here's what the completed unit looks like. The long cable with its plug can be connected to any convenient electrical outlet. There are three outlets for you to plug your lights into and a switch which turns all the lights on or off at the same time.



If you want a pilot light to test the unit or to serve as a warning that the switch is on, you can easily make one from a plug-in socket and a 7 1/2-watt bulb.



This diagram shows how the unit should be wired.

A junction box for multiple flash

This junction box, based on a design developed by Arthur d'Arazien for his industrial work, is planned primarily for use in making open-flash photographs. [With this technique you open your camera shutter the way you do for a time exposure and *then* you fire the flash.] The multiple-flash junction box can be very helpful not only in industrial work but also for photographing interiors, buildings at night, or any other subjects where you may want to use a number of flashbulbs and the open-flash method.

The box has the following features:

1. It allows up to seven different extensions to be plugged into it. [Each of these extensions can be used to feed one or more flash units.]
2. It fires off regular 110-volt household current. *Important: Be sure to use only those flashbulbs designed to be fired by 110-volt current:* Nos. 2, 2B, 3, 3B, 22, 22B, 50, and 50B.
3. The junction box has a master switch that enables you to turn the current to all outlets on or off.
4. It also has an outlet where you can attach an extension cord with a push-button switch for firing the bulbs from camera position.
5. It has an amber pilot light which goes on whenever the unit is plugged into a live electrical outlet, and a red warning light that goes on when the master switch is in the "on" position.

Constructing the unit

To construct the unit, first knock out the center plug in one side of one box. [Use this box to hold the toggle switch and warning light.] Then knock out the center plug on *both* sides of the remaining five boxes. Use two screws each to attach the boxes to the plywood base. Cut off an adequate length of wire from your cable and use this to make the necessary electrical connections between the various components, following the plan of the accompanying wiring diagram. [As we mentioned before, you can have an electrician do this if you don't want to attempt it yourself.]

Connect the two-prong plug to one end of your cable and connect the other end of the cable to the amber pilot light. Secure the cable to the box with a cable connector. When you've completed all wiring, attach the outlets to the boxes and put the covers on the boxes. Take your lamp cord and connect a plug to one end and a push-button switch to the other.

This unit is primarily designed for use with flashbulbs. However, you also can run floods or spots off it if the *total* wattage of the lights is not greater than 1,500 watts.

If you want modeling lights to guide you in placing your lighting units before taking the flash picture, use low-wattage bulbs so you don't overload the circuit–for example, six No. 2 photofloods, or ten 150-watt light bulbs.

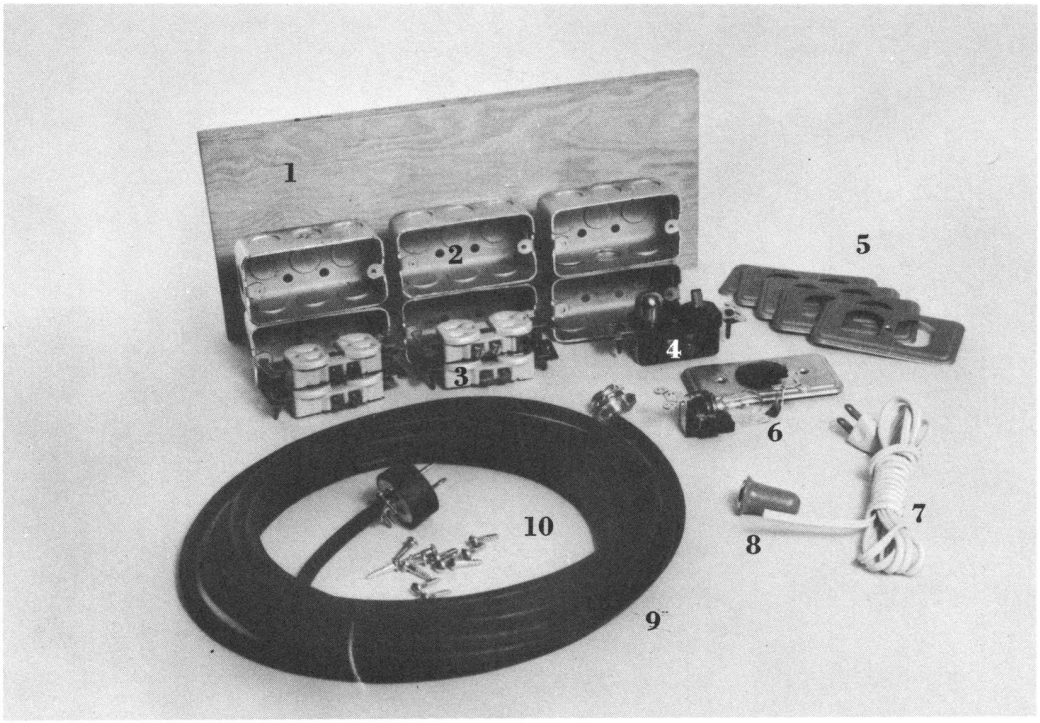
A good procedure to follow when using modeling lights and flash is this:

1. Plug in the main cable. [If electricity is reaching the junction box, the amber pilot light will go on.]
2. With the main switch *off*, screw your modeling lights into your lighting units, connect the lighting units to the junction box, and turn each of the lighting units on.
3. Turn on the master switch at the junction box. The red warning light will

go on, and so will all the modeling lights. Arrange the lights to give the effect you want.

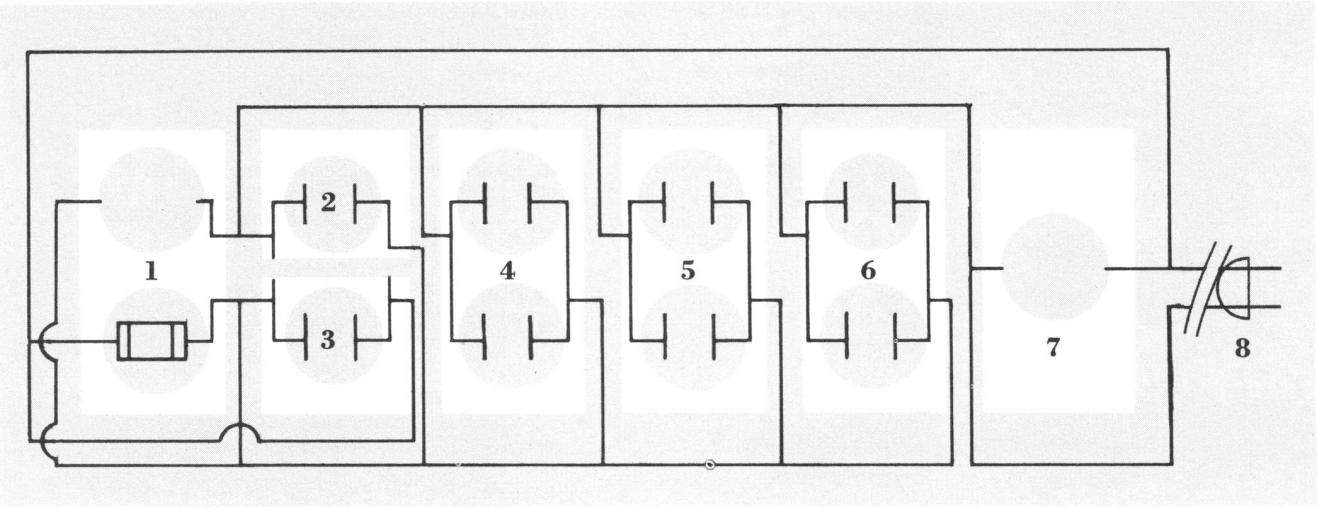
4. Turn off the master switch. *Make absolutely certain it is off.*
5. Replace each modeling light with the correct type of flashbulb.
6. When you are ready to take your picture, open the camera's shutter, fire the bulbs [either by closing the master switch or using the push-button switch on an extension] and then close the shutter.
7. Before removing any burned-out flashbulbs, let them cool off, and be sure the master switch is off.

What you need

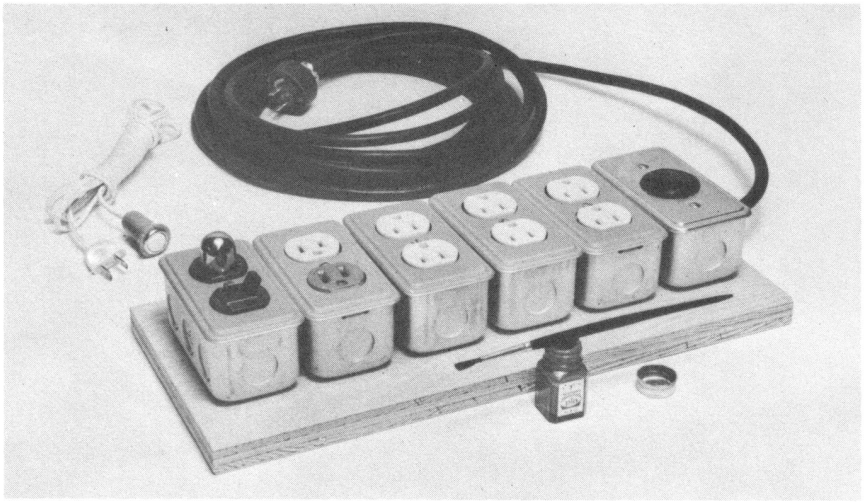


[Note: We've identified some of the parts by brand name. This is intended as a guide only, not necessarily as a recommendation. Similar items by other manufacturers may be equally suitable. Follow the advice of your electrical supply or hardware dealer.]

1 Base for the unit–3/4-inch sheet of plywood measuring 6x15 inches.
2 Six boxes [surface-mounting type to hold standard double outlets].
3 Four double outlets. [Important: One of these must have the electrical connection between its two halves broken. See picture on page 191.]
4 One toggle switch and red light. [This is the master switch.]
5 Five double-outlet covers for boxes. [The sixth box has a special cover with an amber light–see next item.]
6 One Arrow-Hart 1711 amber light and box cover.
7 Ten feet [more or less as required] of lamp cord and two-prong plug.
8 One push-button switch.
9 Twenty-five feet [more or less as required] of 14/2 rubber-insulated cable, a two-prong plug to fit the cable, and a cable connector to secure one end of the cable to a box.
10 Twelve 3/4-inch wood screws to attach boxes to base.



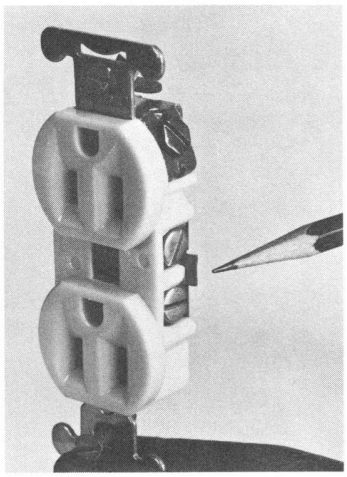
Wiring diagram **1** Master switch and red warning light. **2** Double outlet with its two halves disconnected. **3** The outlet you should use for your extension cord and push-button switch. [Paint this outlet red for easy identification.] **4, 5, 6** Double outlets. **7** Amber pilot light. **8** Cable and plug.



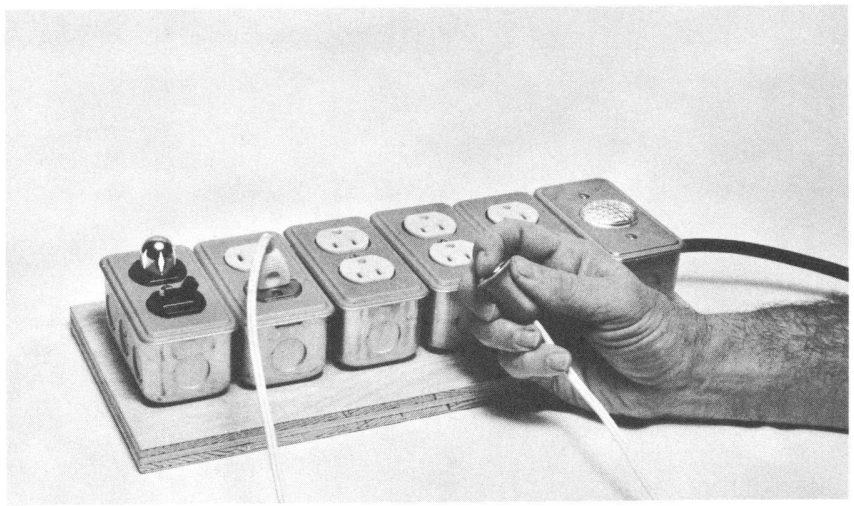
Here's what the completed unit looks like. The six boxes are mounted on the plywood base side by side and almost touching each other. The end box at left contains the master switch and warning light. When you turn the switch on, electricity reaches all the outlets and the warning light glows red. *Never remove or insert a flashbulb when this light is on!*

The next box contains the double outlet in which the electrical connection between the two halves has been broken. [The front outlet is the one you should use when you plug in your push-button switch.] We suggest you paint this outlet red [with plastic model paint] for easy identification, as we have done here with the brush and paint in the foreground.

The other seven outlets are for your flash units. The box at far right contains an amber light that turns on when you plug the main cable into a live outlet. In the rear at left is the push-button switch and its extension cord. Coiled up next to it is the cable.



You need to break the electrical connection between two halves of one of your double outlets. With this particular make [a Leviton Duplex 1215], you do this simply by taking a pair of pliers and breaking off the small metal lip we are pointing to with a pencil. [The lip is provided for exactly this purpose.] With other makes of outlets the method may be different. When you buy your outlets, ask the dealer how to break the connection.



To use the push-button switch, you plug the extension cord into the correct outlet. When you push the button, *current will reach all the other outlets,* thus firing the flashbulbs. You can make the extension cord as long as you want, and thus operate the flash units from camera position or any other convenient location within reach of the cord.

A light box

You'll find many good uses for this inexpensive, easy-to-make light box. It can be used for studying your negatives and evaluating them in terms of contrast and density; for viewing color transparencies; and also as a retouching stand.

As you can see from the accompanying photographs and diagrams, the box has a triangular design, with a front [containing a sheet of translucent opal

glass], a back, and a bottom, but with the sides open. You can construct it from 1/2-inch plywood, pine, or any other easy-to-work wood, and finish it to suit your taste. [Our sample model here was made from Philippine mahogany and given a natural finish.]

Before starting to work, check the list of parts and materials and make certain you have everything you need. Use the accompanying diagrams and photographs as a guide in constructing the unit.

What you need

Three pieces of 1/2-inch plywood, pine, or mahogany. Each piece should measure 10x12 inches.
Three triangular corner cleats, 7/8x7/8x7/8 by 10 inches long.
Four strips of 3/16x3/8 pine stock to support the glass. You'll need two pieces about 8 1/2 inches long and two about 10 1/2 inches long to be cut to exact length to fit the opening in the front of the box.
Four glass-retaining strips, same dimensions as the supporting strips, to hold the glass against them. [Use pine stock or wood that matches the viewing box.]
One 8x10 sheet of opal glass. [If your glass supply store doesn't have this in stock they should be able to order a piece for you.]
Eighteen 1-inch No. 6 flathead wood screws.
One standard surface-mounting porcelain or plastic light socket.
One 6-foot [more or less as required] length of lamp cord.
One 2-prong plug to fit cord.
One 25- or 40-watt light bulb.
One switch [optional]. We recommend a type that can be wired into the lamp cord just outside the box.
White glue, can of flat white paint, and stain or other finish as desired, for the outside of the box.

Making the box

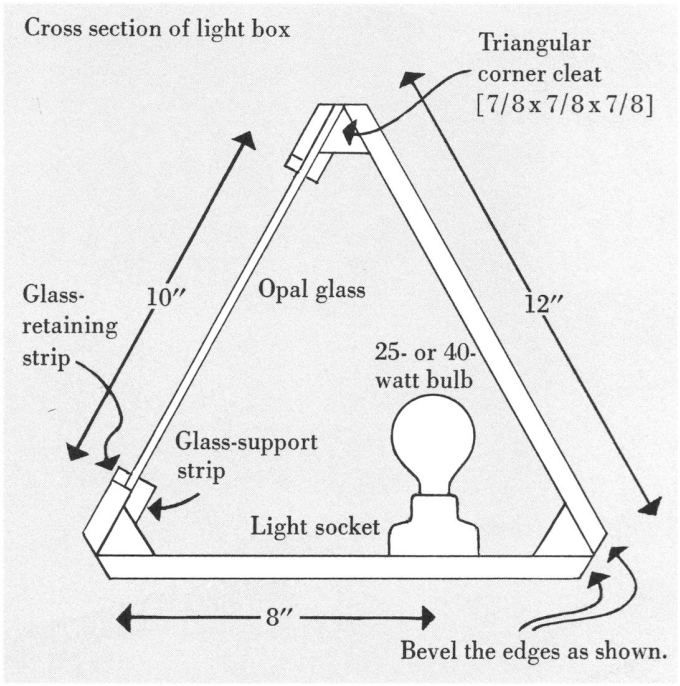
To make the box, take one of your 10x12-inch pieces of wood and cut out an opening measuring 8x10 for the glass. This piece will be the front of your unit. Check to be sure your piece of glass fits easily into the opening. [Enlarge the opening slightly if it's too tight a fit.] Using white glue and screws, assemble your unit, following the directions in the accompanying diagrams.

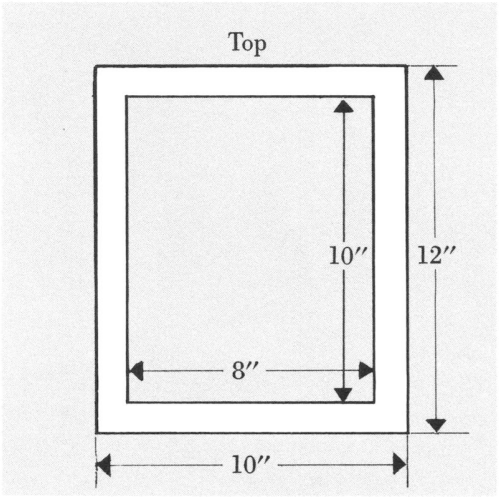
Cut the four glass-support strips exactly to length from your 3/16 x 3/8-inch stock. Butt the corners and glue the strips in place around the *inside* of the opening in the front. The strips should extend about 1/8 inch into the opening to back up the sheet of glass.

Now paint the entire inside of the box with at least two coats of flat white paint. When the paint is dry, wire the socket and install it.

Next, place the sheet of opal glass in position against the glass-support strips. Cut four glass-retaining strips exactly to size and glue them in place to hold the glass against the support strips. [The retaining strips will be visible when you look at the front of the box. If you want them to match the box for appearance' sake, use the same type of wood for these strips as you use for the box.]

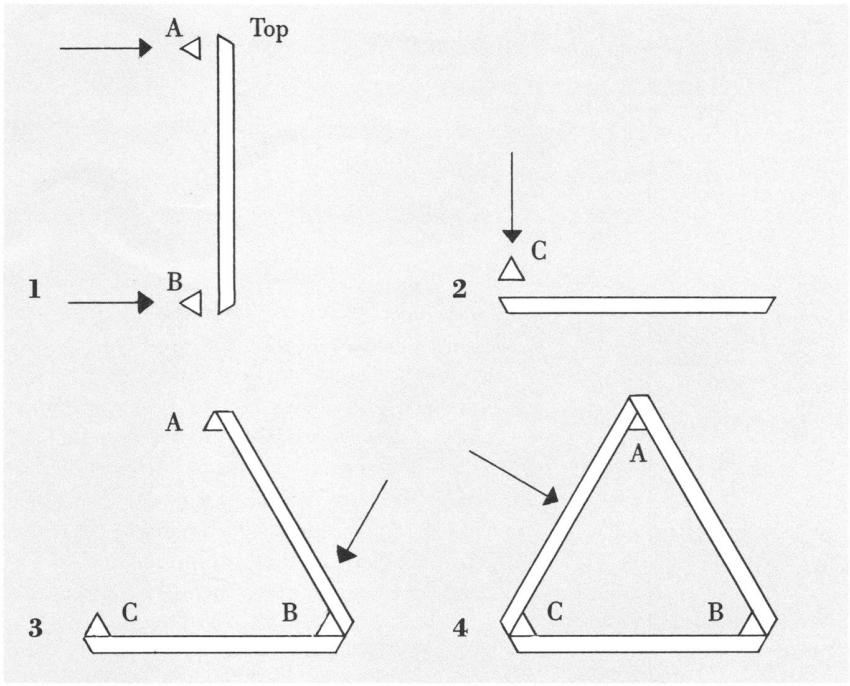
Screw a 25- or 40-watt bulb [depending on the intensity of illumination you prefer] into the socket and plug in the cord. For added convenience you might want to put a line switch on the cord so you can turn the light on or off without disconnecting the plug.





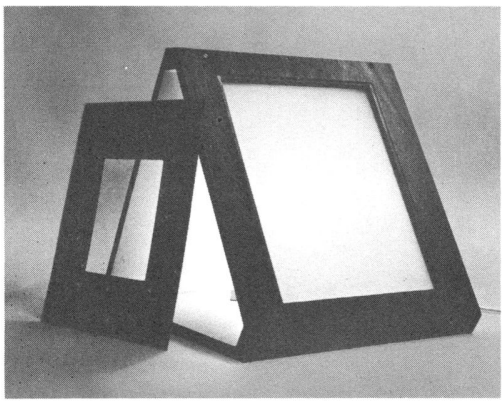
The piece of wood for the front of the light box should have an opening cut into it as shown.

How to assemble the light box

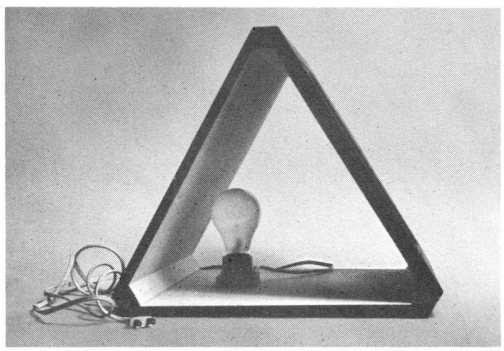


1 Screw and glue corner cleats A and B to the front.
2 Fasten corner cleat C to the bottom.
3 Fasten the front to the bottom.
4 Finally, add the back.

Light box
[*continued*]

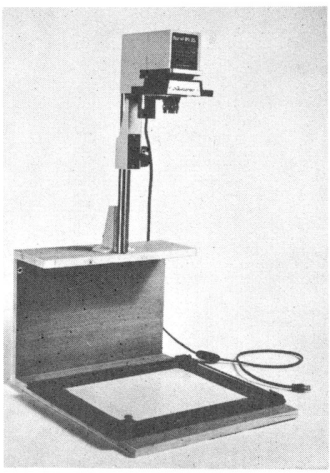


Here's the completed light box. To use it as a retouching stand, make a black cardboard mask with an opening approximately the size of the negative you are working on. Such a mask is leaning against the side of the box.



Here's a side view of the light box showing its open-ended construction and the bulb screwed in place.

An elevated base for an enlarger



With some models of enlargers [particularly very compact makes for smaller film sizes] you sometimes may find it impossible to raise the enlarger head high enough to get the degree of enlargement you want. With most models, you can rotate the head. This enables you, for extra magnification, to project the image over the edge of the table on which the enlarger is resting, and onto your enlarging easel on the floor. There are also some enlargers that you can turn on the side to project on the wall. However, if you consistently find that you need more magnification than your enlarger gives in normal position you may want to find a permanent solution to the problem. This elevated base is designed to provide you with that solution. *It enables you to increase the height of the enlarger head by mounting the enlarger on a shelf raised above the base.*

You'll need to test your enlarger to find the exact dimensions of the elevated base that work best for you. For example, an enlarger for 35-mm film, with a standard 50-mm enlarging lens, requires a lens-to-paper distance of about 27 inches to give you an 11x14 enlargement. Let's say you have a small 35-mm enlarger with a head that raises only to about 18 inches. You'll need a shelf that's at least 9 inches high [27 minus 18]. Actually, you should add 2 or 3 inches for somewhat greater magnification and freedom to crop.

The shelf should be deep enough to securely hold your enlarger post, but should not extend so far it blocks off any of the image when your enlarger head is raised to its full height. Again, this measurement is something you'll need to work out carefully by checking with your particular enlarger. [In the materials list that follows, the dimensions of the wood are only for the example shown.]

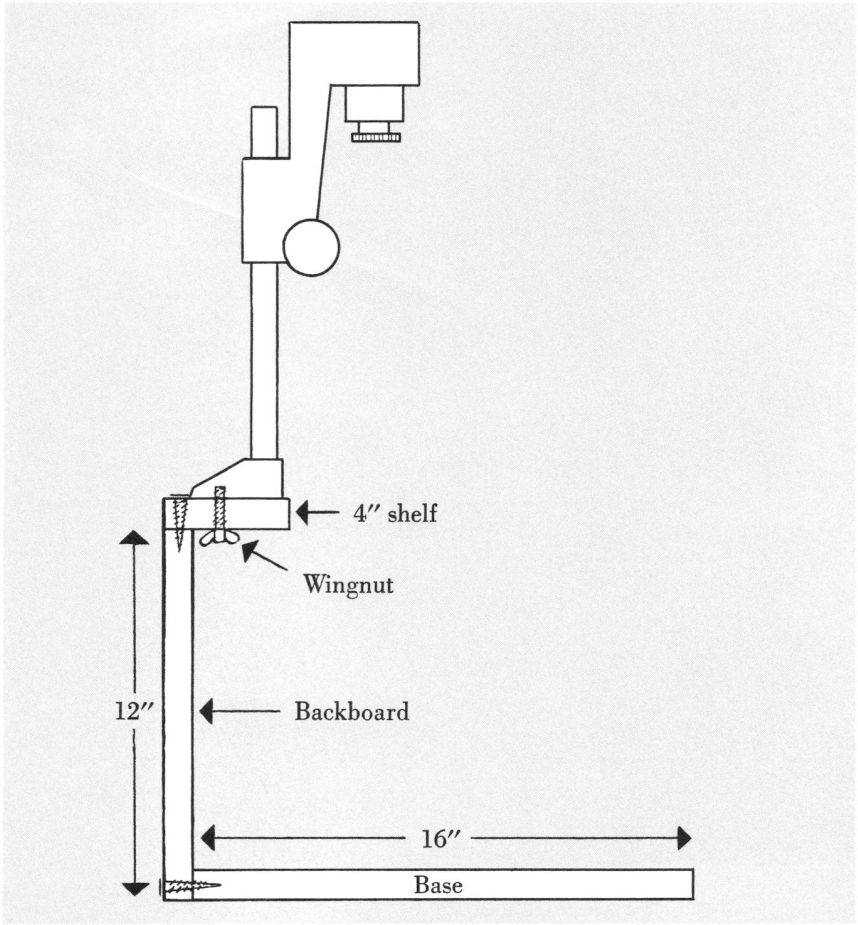
What you need

Three 3/4-inch pieces of plywood, as follows:
- One piece 16x16 for the base.
- One piece 16x12 for the backboard.
- One piece 16x4 for the shelf.

Six 1 1/2-inch No. 8 flathead brass woodscrews.
One wingnut to fit the mounting bolt of your enlarger.
White glue and paint, stain, or other finish as desired.

Assembling and mounting

Assemble the base, backboard, and shelf with glue and screws. Remove your enlarger post from the enlarger base. Drill or bore a hole in the shelf large enough to insert the bolt at the bottom of the enlarger post. Insert this bolt and fasten securely with a wingnut, as shown. Be sure the assembled unit is rigid.

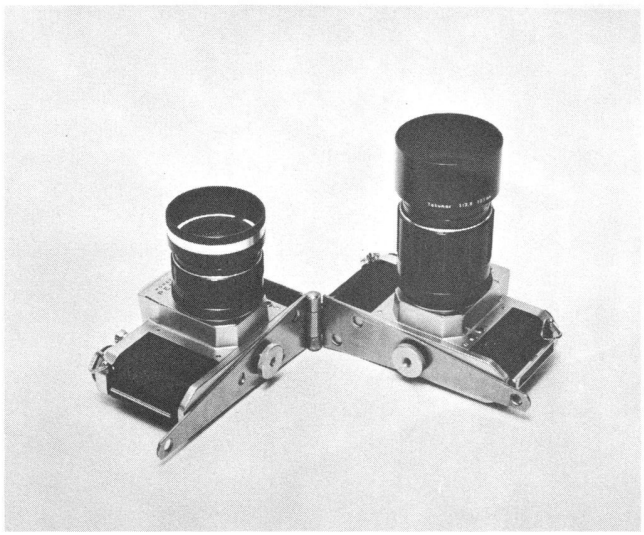


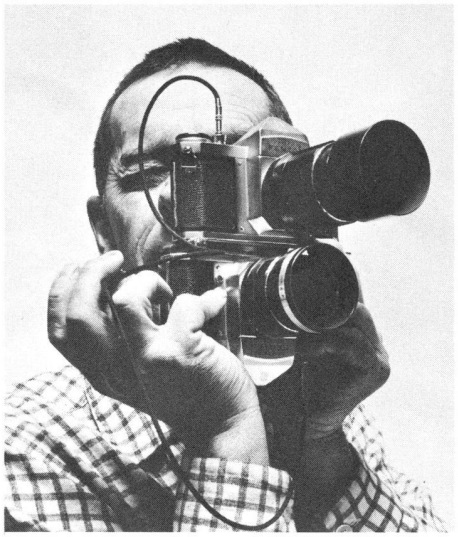
A device for shooting two cameras at once

Here's a simple device that makes it easy to shoot two cameras at once. You might use it when you want to make photographs simultaneously in color and black and white, or to take two pictures at the same time with different lenses. The device is designed for use with 35-mm cameras that have a tripod socket in their base.

First, you'll need a strap hinge, each leaf of which is long enough to hold the camera base securely. For each camera you'll need a tripod screw with a knurled knob. You should be able to obtain these through your camera dealer. You simply drill a hole in each leaf and attach the camera by means of a tripod screw inserted through each hole. [Position the holes so that the two knobs don't touch each other when you close the hinge.]

To use the device, close the hinge. Now one camera–right side up–will be on top and the other camera–upside down–will be on the bottom. You can quickly



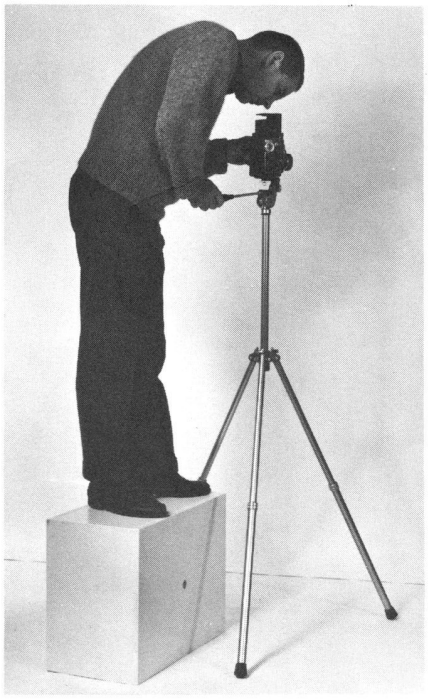


Above, two 35-mm cameras can be attached to the leaves of a hinge for double shooting. [Of course, this device can't be used with cameras that have a film-advance lever on the base.] Below, a dual cable-release holder makes it easy to trip the shutters of both cameras at once.

reverse them for focusing purposes and for convenience in setting the camera controls. In taking the picture it doesn't matter if one camera is upside down. You simply print the picture right side up.

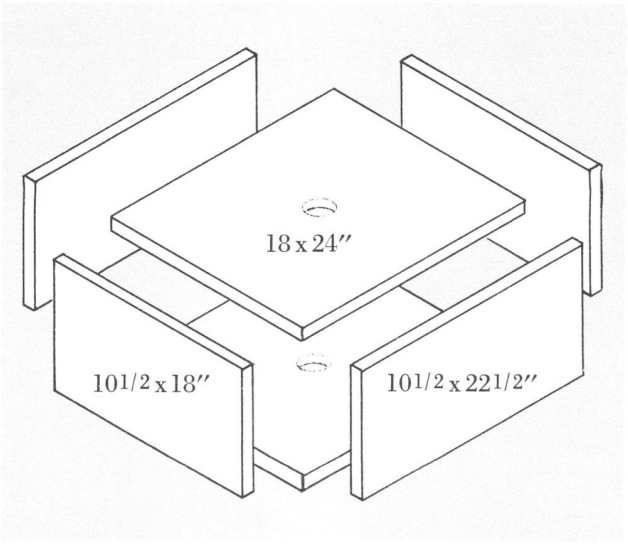
To operate the two cameras simultaneously, make yourself a dual cable-release holder like the one we show in an accompanying picture. Cut a thin piece of wood to a size convenient for holding in your fingers and drill two holes large enough for you to insert your cable releases [they should be of the locking variety]. Remove the locking end of each, pass the cable release through the hole, and refasten the end.

A small studio platform



This simple platform has a number of uses around a studio. Depending on which way you turn it, it gives you a small platform that is two feet high, 18 inches high, or 10 1/2 inches high. It can be used for a model or portrait subject to sit on, to hold your camera tripod for a high-angle shot, to enable you to get up high enough to look down into the top of a twin-lens reflex on a tripod with extended legs, to hold small objects for a how-to or still-life picture, etc.

You can make the platform from 3/4-inch-thick plywood. You'll need two pieces each of 18x24, 10 1/2 x 18, and 10 1/2 x 22 1/2. Using the accompanying diagram as a guide, nail the ends to the sides [the ends should be on the outside], and then nail the top and bottom in place. Use finishing nails and sink them below the surface so the heads won't scratch the floor. [If you glue the pieces together as well as nail them, you'll get a sturdier box.] The box can be stained or painted to suit your taste.



Nail the ends to the sides, then nail on the top and bottom. If you wish, bore holes for easy lifting.

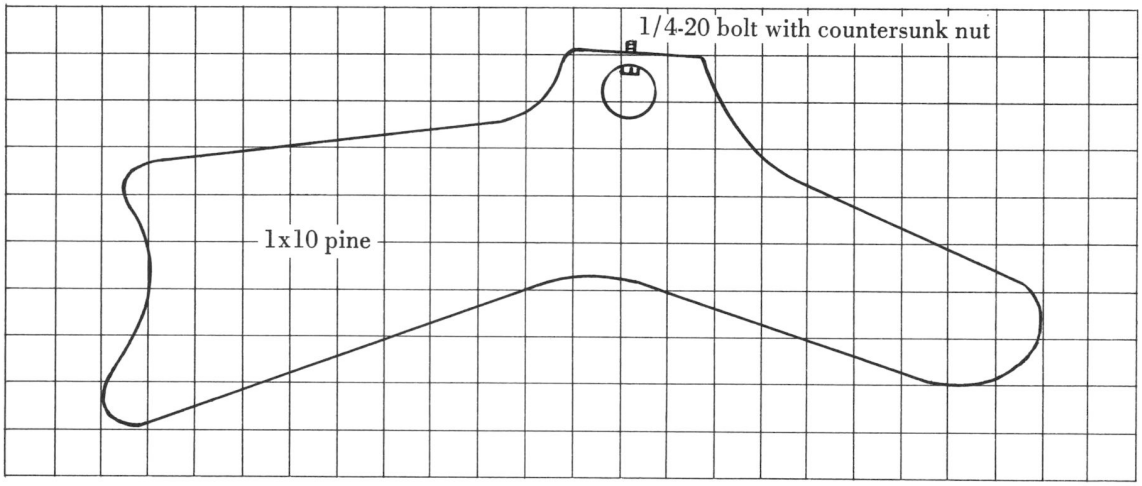
A gunstock camera holder

Here is a plan to use as a guide in making the gunstock type of camera holder demonstrated on page 14 of our lesson on special methods. To make the holder, take a 1x10 piece of pine about two feet long and rule vertical and horizontal lines on it one inch apart. Use the squares formed by these lines to help you mark the outline of the gunstock on the pine, following the plan we give you here. [The plan is drawn to scale with each square representing one square inch.]

Cut along the outline with a coping saw, jigsaw, or band saw. Bore the large hole, and then drill a quarter-inch hole vertically in the top of the stock so you can insert a 1/4-20 bolt and countersunk nut as shown on the plan. You can attach your camera directly to the bolt, using the camera tripod socket, or you can mount an accessory sliding camera platform on the gunstock and attach the camera to the platform.

Shape and smooth the gunstock with a file or wood-shaping tool, rounding the sharp edges of the wood. Finish with sandpaper, and stain or paint the gunstock for an attractive appearance and protection.

You can make the stock longer or shorter and modify the shape, depending on the length of your arms and the design of the camera you're using. The important thing is for the stock to fit snugly against your shoulder and for the eye to meet the camera viewfinder comfortably. When you use the stock, attach a cable release to your camera. The cable should be long enough to reach one hand comfortably as you grip the stock with both hands.



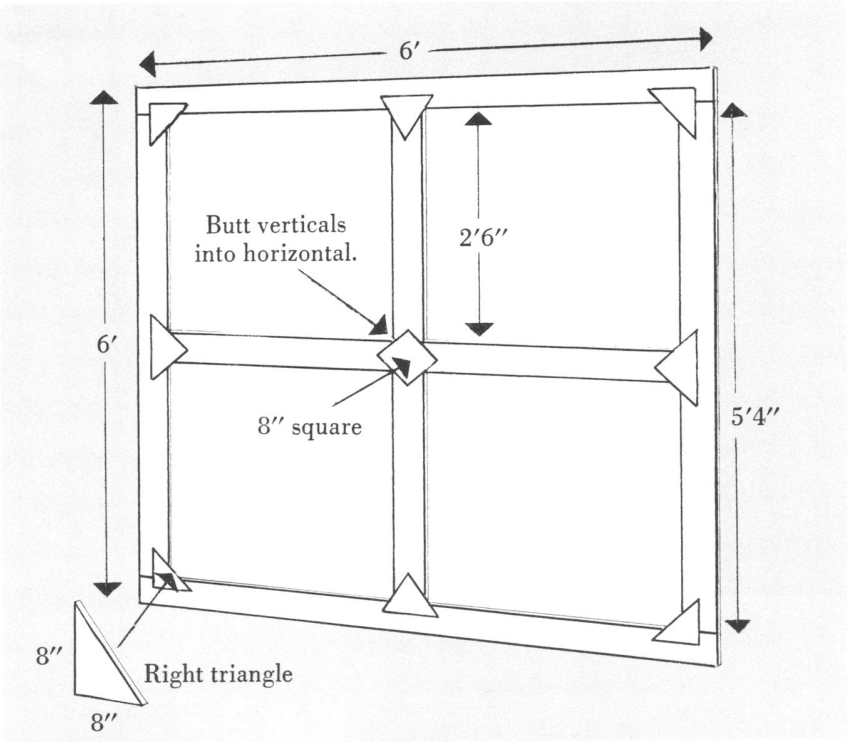
A studio flat

Here is a basic plan for constructing a studio flat as shown on page 28 of our lesson on professional procedures. You can make the flat larger or smaller as desired. For sizes up to about 8x8 feet we suggest you use 1x4 pine stock for the frame. For larger sizes, 1x6 stock is desirable to give you sturdier construction. A vertical crossbrace should be added every three feet. The flat is held upright by clamping it to standards, as we demonstrated in the lesson.

What you need [for a 6x6-foot flat]

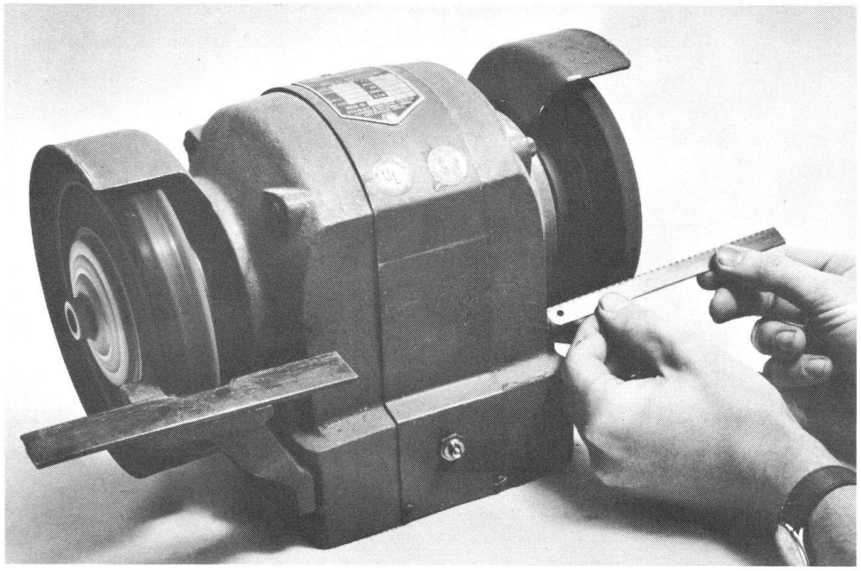
Seven pieces of 1x4 pine in the following lengths:
- Two 6-foot pieces [for the top and bottom].
- Three 5′4″ pieces [for the sides and horizontal crossbrace].
- Two 2 1/2-foot pieces [for the vertical crossbrace].

Eight 8x8-inch right triangles and one 8-inch square of 1/4-inch plywood [to reinforce the joints].
Supply of 3/4-inch galvanized roofing nails.
Staples and staple gun.
Can of wall size.
Can of latex-base paint.
Sufficient unbleached muslin or lightweight canvas to cover one side of the flat. [If you require two pieces, tear the cloth so the joint comes at a crossbrace. Seal the joint with wallpaper paste to make it smooth, and then paint over it so it won't show.]

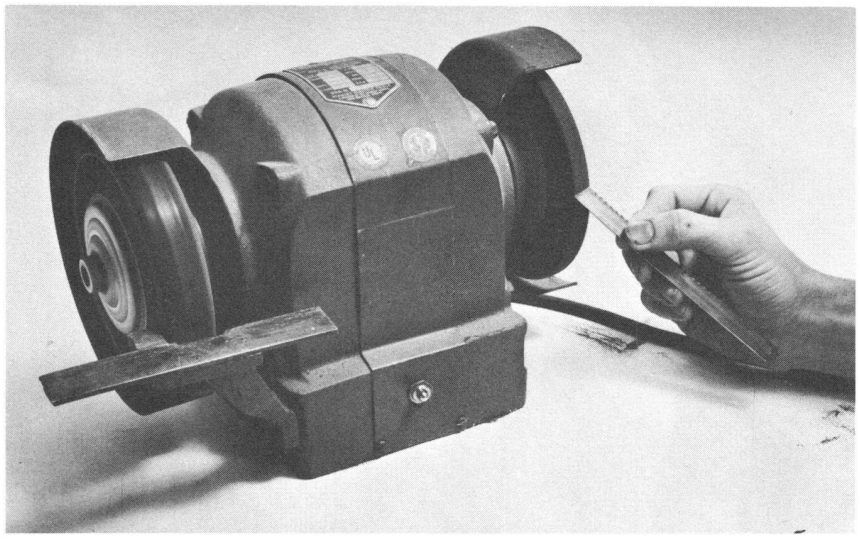


A retouching knife

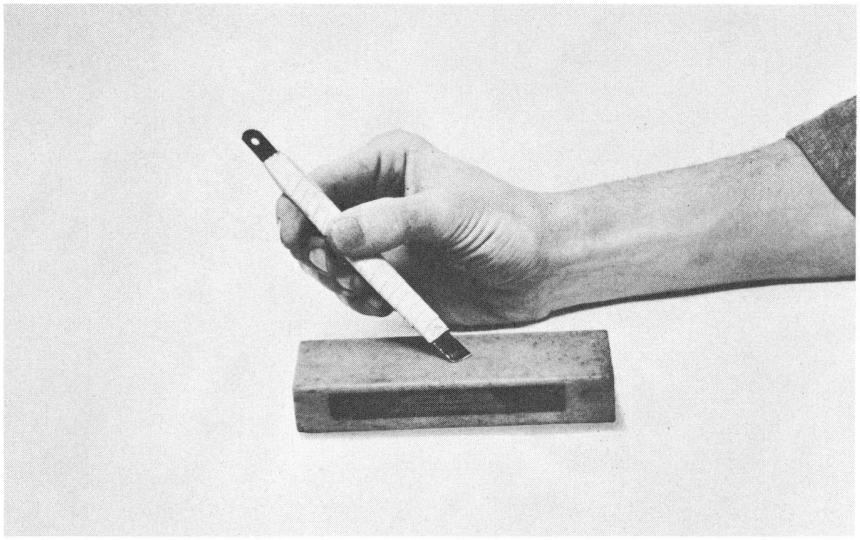
You can buy a retouching knife ready-made, but you also can make your own from a hacksaw blade. The hard, brittle steel used in these blades is excellent for retouching work.



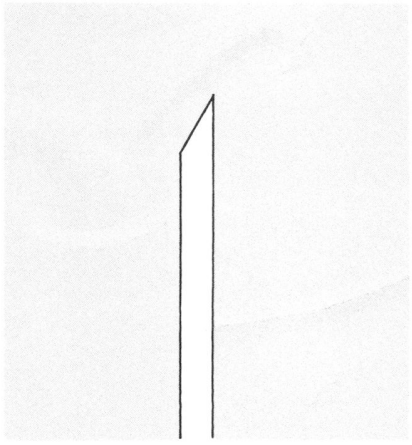
1 Break the hacksaw blade in half. This will give you material for two knives. Grind off the teeth with a power grinder, or have this done for you.



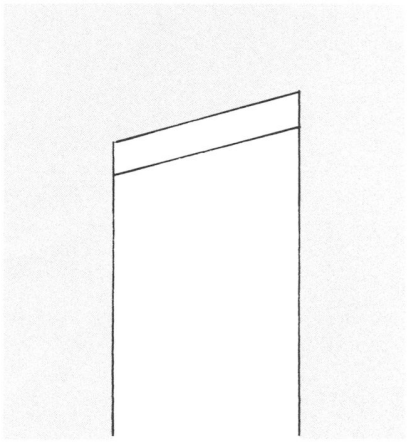
2 Grind an edge on the broken end of the blade. [The end with a hole in it should be used as the handle portion of the knife.] See the diagram for a cross section and front view of the blade, and use these as a guide in grinding the blade.



3 Wrap the blade with masking tape to make a comfortable handle. Use a sharpening stone to hone a sharp edge. Hold the blade at an angle as shown here and apply pressure as you stroke it *toward* yourself. During each stroke, turn the blade so you end the stroke with the knife in an almost vertical position. This puts a burr–a very fine, slightly upcurled edge–on the cutting edge of the blade. As we demonstrated in our lesson on professional procedures, this burr is what you use to shave the negative when removing emulsion.



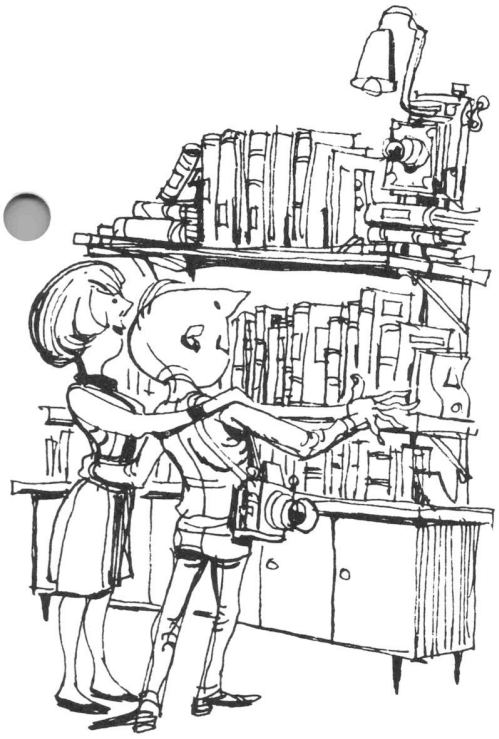
Cross section of blade.



Front view of blade. [You can use just a corner for a fine cut, or more of the blade for a broader cut.]

13

A selection of good books for photographers



One of the best ways to insure your continued growth as a photographer is to acquire a personal library of good photographic books. Books can bring you up to date on new equipment and techniques, suggest fresh ideas and approaches, and broaden and deepen your understanding of photography.

This section includes a listing of good books on many aspects of photography and is intended as a guide to help you build your own library or locate books on special subjects that interest you. It is by no means a complete list of all the good photographic books available, but it is a selected listing of more than 100 titles that have proven their worth.

Most of the books included here can be obtained through your local photo dealer or bookstore. If the title you want isn't in stock, it usually can be ordered for you. Before investing in a book that's not in stock, you might check with your library to see if they have a copy. Then you can examine the book and see if it contains the information you're interested in before you buy it.

New titles appear frequently and other books become "out of print." If you can't locate a book you want in the usual way, you may be able to find it on sale as a "remainder" at some bookstores. Marboro Books, 131 Varick St., New York, N.Y., often have remaindered photographic books–especially picture books–and should be able to supply you with a current list of titles.

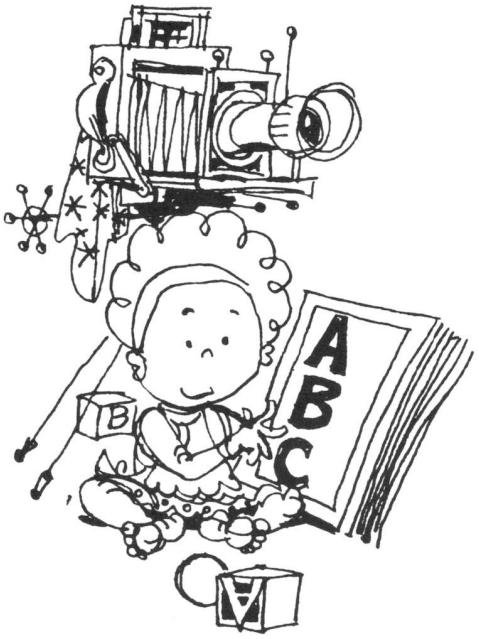
If there is no bookstore or photo dealer near you, you may be able to obtain the title you want from:

Amphoto
915 Broadway
New York 10, N.Y.

or

Customer Service
Doubleday Book Shop
724 Fifth Avenue
New York, 19, N.Y.

The prices listed are correct as of the date this Technical Manual went to press. However, publishers frequently change prices, so check before you order.



Basic reference and technical books

The Encyclopedia of Photography, 20 volumes, $3.98 per volume. A fascinating potpourri of articles [varying widely in quality] on just about every imaginable phase of photography.

Exposure, by W. F. Berg, $5. A detailed study of photographic exposure both from the theoretical and practical standpoint.

Focal Encyclopedia of Photography, $20, desk edition, $7.95. Concise, authoritative, and comprehensive. The desk edition omits half-tone illustrations, but otherwise is complete.

How Photography Works, by H. J. Walls, $8.50. A readable treatment of photographic optics, chemistry, and visual perception from the standpoint of the intelligent non-technician.

Ilford Manual of Photography, by A. Horder, $8. Although the emphasis is on Ilford products, this is an excellent all-around photographic reference book.

Kodak Reference Handbooks, Vol. I and II, $4.00 each. The most authoritative word on Kodak black-and-white films, papers, chemicals, etc.

Photo Lab Index, edited by John S. Carroll, $19.95. A huge, comprehensive compilation of photographic facts, figures, technical data, formulas, etc. More than 1,400 loose-leaf pages.

Photographic Optics, by Arthur Cox, $5.75. A classic treatment of this important subject. Now in its 12th edition.

Photography: Its Processes and Materials, by C. B. Neblette, $15. A standard classic of technical writing about photography.

The Theory of the Photographic Process, by Kenneth Mees, $21.50. An exhaustive technical treatment of the subject.

Camera guides and manuals

More than most photographic books, camera guides and manuals tend to quickly become dated. Also, many are little more than a rehash of material you can find in the manufacturer's official instruction book.

A superior series of camera guides are those by W. D. Emanuel [$1.95 each] for Baldessa, Contaflex, Contarex, Contax, Contina, Edixa Reflex, Exakta-Exa, Hasselblad, Ikoflex, Leica, Minox, Optima, Pentax, Retina, Retina Reflex, Rolleiflex, Super Ikonta, Vitessa, Vito, and Vitomatic cameras.

Some other camera books of unusual value and with enduring qualities are listed below.

Argus 35-mm Photography, by Burt Murphy, $1.95. A comprehensive guide to an old and famous line of American-made cameras.

Contaflex Manual, by E. S. Bomback, $7.95. Probably the most complete guide to the Contaflex and its accessories.

The Contarex Way, by H. Freytag, $8.95. The definitive book on the Contarex camera, divided into three sections–for the beginner, the advanced amateur, and those requiring highly specialized information and data.

The Contax Way, by H. Freytag, $5.95. Detailed information about a classic line of 35-mm cameras.

Graphic-Graflex Photography, by Willard D. Morgan, $6.95. The latest edition of a book devoted to press and view-camera techniques.

Keppler on the Eye-Level Reflex, by Herbert Keppler, $4.95. A frank, opinionated analysis of what's right and what's wrong with today's 35-mm prism reflex cameras.

Leica Manual, by W. D. Morgan, $6.95. The standard guide to 35-mm photography with Leica cameras and lenses, including many reference charts and tables. Frequently revised, so get the latest edition.

Linhof Practice, $8.95. Emphasis on Linhof equipment, but much information and data of interest to all users of view and press cameras.

The Minox Manual, by Joseph Cooper, $4.95. An authoritative guide to this popular make of subminiature camera.

The New Ultra-Miniature Photography, by Joseph D. Cooper, $3.95. A basic handbook of subminiature equipment and techniques, including a directory of cameras, films, and accessories, and detailed directions on developing and enlarging subminiature pictures.

The Nikon Manual, by George W. Wright, $5.95. Not only a guide to Nikon equipment [some of which material needs updating] but also a basic text on good 35-mm technique.

Official Nikon F Reflex Manual, $2.50. Covers all aspects of the Nikon F camera including lenses, accessories, depth-of-field charts, etc.

Pictures in a Minute, by John Wolbarst, $3.95. Excellent how-to book on Polaroid photography.

The Retina Reflex Way, by L. A. Mannheim, $7.50. This book deals with its subject in an exhaustive way, emphasizing the versatility of the camera and its accessories.

Rollei Photography, by Jacob Deschin, $5. Although new models have made some of its technical information incomplete and out of date, this book remains one of the best camera guides ever written. It is a fine blend of the technical and creative aspects of photography, and the sections contributed by Philippe Halsman, Fritz Henle, Arthur Rothstein, Andreas Feininger, and Joseph Breitenbach are fresh and stimulating.

The Rollei Way, by L. A. Mannheim, $6.95. One of the most complete books available on the Rolleiflex and Rolleicord cameras.

Single-lens Reflex Photography, by Joseph Cooper, $1.95. A generally reliable and comprehensive guide to all brands in this fast-growing field.

35-mm Photo Technique, by H. S. Newcombe, $4.50. Probably the best single book on miniature photography in general yet published.

Books on color

Better Color Slides Outdoors, by Fred Bond, $1.95. A clear, informative text covering the practice of outdoor color photography.

Eye, Film and Camera in Color Photography, by Ralph M. Evans, $8.95. Actually, this penetrating book on the psychology of vision is broader in scope than the title indicates. By a noted research scientist, it is of interest to all serious photographers.

How to Make Your Own Color Prints, by Robert Bagby, $4.50. A good instructional book on basic methods in this complex but fascinating field.

Kodak Color Dataguide, $4.95. Filled with helpful charts, tables, calculators, and other data to help you in exposing, developing, and printing color.

Kodak Color Handbook, $5. A basic reference book for all Kodak color materials–films, papers, chemicals, filters, etc.

Developing and printing

Developing, by C. I. Jacobson, $4.50. A comprehensive textbook on the theory and practice of precision film developing, with many reference charts and tables.

Enlarging, by C. I. Jacobson, $4.50. A thorough coverage of basic and advanced enlarging methods. This is a standard reference work on the subject, although relatively weak on modern papers.

How to Develop, Print, and Enlarge Pictures, by Samuel Epstein and David W. De Armand, $1. A lively introduction to darkroom work told almost entirely in pictures-and-caption style.

How to Use Variable Contrast Papers, by Lou Jacobs, Jr., $2.50. Much useful information and advice on how to get good results from different variable-contrast printing papers.

Lootens on Photographic Enlarging and Print Quality, by J. Ghislain Lootens, $4.95. The classic book on the subject, recently updated and expanded.

35-mm Negs and Prints, by Y. Ernest Satow, $2.50. A concise survey of modern 35-mm developing and enlarging methods.

General books on photography

Basic Photo Series, by Ansel Adams. Five volumes: *Artificial Light Photography, The Negative, The Print, Camera and Lens,* and *Natural Light Photography,* $3.95 each. A precise but complex approach to photography through the "zone system" of exposure.

Camera Techniques, by H. J. Walls, $5.75. A thorough coverage of picture-taking methods from a technical viewpoint.

The Creative Photographer, by Andreas Feininger, $4.95. Techniques and approaches for the more advanced photographer.

Getting Started in Photography, by Les Barry, $1.95. A good beginner's book covering the basic essentials.

Guide to Creative Photography, by Harold J. Highland, $3.95. A simply-written book for neophytes.

How to Make Good Pictures, Kodak, $1. A simple, profusely illustrated introduction to picture-taking.

How to Take Better Pictures, by Arthur Goldsmith, $2.50. A concise, readable book for beginners.

Say it With Your Camera, by Jacob Deschin, $4.95. A stimulating, well-illustrated coverage of the creative aspects of picture-taking.

Successful Photography, by Andreas Feininger, $4.95. A practical, well-rounded coverage of the fundamentals of photography.

This is Photography, by Thomas Miller and Wyat Brummitt, $3.50. A clear, nontechnical survey of basic photographic theory and methods.

Total Picture Control, by Andreas Feininger, $7.50. A distinguished *Life* photographer surveys the creative controls of photography in a lavishly illustrated book.

History

The History of Photography, by Helmut and Alison Gernsheim, $18.50. The history of photography to 1914, in exhaustive but fascinating detail, by two leading British historians of photography. Particularly strong in the area of technical developments.

The History of Photography, by Beaumont Newhall, $3.95. A first-rate, readable survey of the technical and esthetic growth of photography from 1839 to the present day. Everyone with a more than passing interest in photography ought to read this book.

The Picture History of Photography, by Peter Pollack, $17.50. A sumptuous, 600-page panorama of good photography from its earliest beginnings to the present day. Some curious omissions but otherwise an exciting and rewarding book for any student of photography as art.

Lighting

Available Light Photography, by H. M. Kinzer, $1.95. A primer on this important type of photography. Some of the technical information is now outdated, but otherwise a stimulating and useful little book.

Electronic Flash, by Lou Jacobs, Jr., $2.50. A compact, simply-written guide to buying, testing, and using electronic flash equipment.

Movies

American Cinematographers Manual, edited by Joseph V. Mascelli, $7.50. The "bible" of professional cameramen and serious 16-mm amateurs, with many valuable reference charts.

Better Electric-Eye Movies, by Myron A. Matzkin, $1.95. Simplifies the complex and confusing field of automatic-exposure movie cameras.

Film and the Director, by Don Livingston, $4.95. The methods of motion-picture photography from the standpoint of the film director.

Handbook of Basic Motion-Picture Techniques, by Emil F. Brodbeck, $6.50. An authoritative and comprehensive text on moviemaking methods, of interest to professionals and serious amateurs.

Home Movies in Sound, by Burt Murphy, $1.95. Advice on adding sound to your movies with tape recorder or sound-on-film, and an appraisal of available equipment.

How to Shoot a Movie Story, by Arthur L. Gaskill and David A. Englander, $1.95. A pointed and stimulating little book that goes right to the heart of creating good motion-picture continuity.

Movie Techniques for the Advanced Amateur, by George Regnier with Myron A. Matzkin, $4.95. A first-rate book on planning and shooting quality movies with amateur equipment. Includes a clear, readable text and many good photographic examples.

Picture Annuals

A fine source of inspiration and ideas for photographers are the various annuals which include outstanding photographic work of the year. Among the most important are the following:

The Annual of Advertising & Editorial Art & Design [commonly called The Art Directors Annual]

The German Photographic Annual

Photography Annual

U.S. Camera Annual

Picture Books

American Photographs, by Walker Evans, $7.50. A new edition of a famous picture book of 1938, by a photographer whose influence continues to grow.

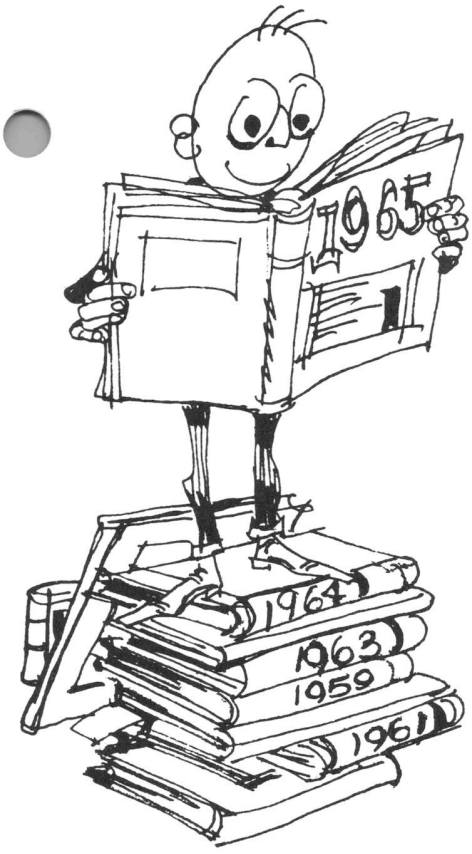
The Americans, by Robert Frank, $7.50. A sometimes savage but always perceptive look at the American way of life, death, and love by a talented Swiss-born photojournalist.

Antarctica, by Emil Schulthess, $15.00. Spectacular views in color and black-and-white of the least-known continent. Unusual wide-format layouts add to the book's visual impact.

The Bare Feet, by Nell Dorr, $10.00. A poetic, intensely personal interpretation of life in a poverty-stricken Mexican village by a compassionate woman photographer.

The Civil War as They Knew It, edited by Pierce Fredericks, $1.25. The photographs of Mathew Brady and the words of Abraham Lincoln are combined in an excellently reproduced pocket-size picture book.

The Decisive Moment, by Henri Cartier-Bresson, $12.50. One of the most important and influential picture books of recent years, containing the earlier work of a great French photojournalist. The introductory essay remains the best statement of the candid approach to photography.



The Family of Man, hard-cover edition, $3.95; paper-back edition, 50 cents. Includes all photographs from the most famous photographic exhibit ever produced–Edward Steichen's "Family of Man" show at the Museum of Modern Art in 1955.

Mathew Brady, by James D. Horan, $4.95. Includes more than 500 photographs by the great Civil War photographer and his talented staff.

Moments Preserved, by Irving Penn, $17.50. A magnificently reproduced selection of Penn's best work in portraits, fashion, still life, and color–photographs that opened up new horizons of photographic seeing and set new trends.

Observations, by Richard Avedon, $15.00. Brilliant, trenchant portraiture by a master of the art, with a fine commentary by Truman Capote.

Perspective of Nudes, by Bill Brandt, $7.95. Controversial but highly acclaimed book that startles with its distorted, extreme wide-angle views of the human figure.

Philippe Halsman's Jump Book, $3.75. Amusing and revealing pictures of celebrities caught in mid-air.

Photography at Midcentury, $2.50. A well-rounded survey of modern trends and forces in photography. The book was a generously illustrated catalogue for the Tenth Anniversary Exhibition at George Eastman House, Rochester, New York [1959]. Available from Eastman House.

Portraits of Greatness, by Yousuf Karsh, $20.00. An impressive, if sometimes ponderous, collection of portraits of notable people of our time. Lavish gravure reproduction.

Steichen, $19.50. Edward Steichen's autobiography with finely reproduced photographs from all stages of his 53-year career as a photographer.

These We Inherit, by Ansel Adams, $15.00. Beautiful, spectacular landscapes and nature studies by a photographer who combines a poetic eye and technical skill to a rare degree.

The World is Young, by Wayne Miller, hard-cover edition, $10; paper-back edition, $1.50. The photographer's own family of four children were the subjects for this book, a charming study of the pleasures and tensions of growing up.

The World of Werner Bischof, text by M. Gasser, $7.95. A generously illustrated testament to an outstanding photojournalist whose career was ended by a fatal accident in 1954.

Press and photojournalism

The Complete Book of Press Photography, edited by Joseph Costa for the National Press Photographers Association, $7.50. A round-up of newspaper photographers' methods and a collection of outstanding press pictures.

Creative News Photography, by Rodney Fox and Robert Kerns, $3.95. A stimulating and well-illustrated book on the creative aspects of making good press pictures.

Photojournalism, by Arthur Rothstein, $5.95. A concise, interesting survey of how newspaper and magazine picture departments work, how a picture story is conceived and shot, and the functions of the photographer, picture editor, and art director.

Press Photography, by Robert B. Rhode and Floyd H. McCall, $6. A sound, basic text on all phases of press photography.

Words and Pictures, by Wilson Hicks, $5. A thoughtful analysis of photojournalism, its history, and its achievements by a former executive editor of *Life*. The emphasis is on magazines and picture stories. A book of ideas and philosophy as well as a study of actual practices.

Miscellaneous

Advertising Photography, by Roy Pinney, $12.50. A study of the role of photography in advertising today, including outstanding examples from magazines, newspapers, direct mail, posters, catalogs, etc.

Art and Visual Perception, by Rudolf Arnheim, $12.50. Although not primarily a photographic book, this brilliant, scholarly study of creativity and human vision by a leading Gestalt psychologist is of interest to any serious photographer.

Careers in Photography, by Edna Bennett, $1.95. A good survey of the requirements and opportunities in photography as a profession.

Child Photography Made Easy, by J. Schneider, $4.50. Advice from a leading professional on posing and lighting for good pictures of children.

Close-up Photography with Your Camera, by Harold Martin, $2.50. A good basic book on this subject, emphasizing how to get good results with a minimum of special equipment.

Filter Guide, by Norman Rothschild and Cora Wright, $1.95. Just about all the facts you need to know for the use of filters in color or black-and-white photography.

Guide to Perfect Exposure, by George and Cora Wright, $1.95. A helpful wrap-up of exposure methods and the use of exposure meters for color and black-and-white, indoors and out.

Halsman on the Creation of Photographic Ideas, by Philippe Halsman, $3.50. A provocative book about the art of stimulating visual ideas, by a master of the offbeat and the unusual.

How to Make Money in Photography, by Eugene M. Hanson, $1.95. Strong on specific tips and ideas for using your camera to earn cash.

How and Where to Sell Your Pictures Overseas, by Arvel Ahlers, $1.95. A survey of more than 500 European markets for photography.

Mounting, Projecting, and Storing Slides, by Norman Rothschild and George Wright, $1.95. A comprehensive book on types of slide mounts, how to select and test slide projectors, and methods of storing and indexing color slides.

124 Ways You Can Test Cameras, Lenses, and Equipment, by Herbert Keppler, $2.50. A round-up of practical tests requiring a minimum of special knowledge, skill, or testing equipment.

Outer Space Photography for the Amateur, by Dr. Henry E. Paul, $2.50. A good introduction to the hobby of astronomical photography, with directions for adapting amateur equipment to record satellites, meteors, stars, planets, etc.

Police and Crime Photography, by Burt Murphy, $1.95. Covers the fundamentals of photographic applications to police work and criminology.

Portrait of Myself, by Margaret Bourke-White, $5.95. A moving account of a famous woman photographer's career.

Underwater Photography, by Schenk and Kendall, $3.50. A good basic book on the subject.

Underwater Photography Simplified, by Jerry Greenberg, $2. An introduction to the methods of underwater shooting with exposure charts for color and black-and-white.

Where and How to Sell Your Pictures, by Arvel W. Ahlers, $1.95. Excellent, no-nonsense advice on analyzing photographic markets and preparing and mailing photographs plus a detailed listing of specific publications and other markets with their requirements. This book is frequently revised and brought up to date; be sure to use the most recent edition.

Inexpensive books from photographic manufacturers

Here are some excellent buys in photographic books–inexpensive paper-back editions on many topics by photographic manufacturers. Most are available at camera stores, or can be ordered directly from the manufacturer.

Ansco [Binghamton, N.Y.]

Color Fun, 50 cents.

Edmund Scientific Co. [Barrington, N.J.]

All About Telephoto Lenses, 65 cents.

Photography With Your Telescope, 25 cents.

Kodak

For a complete list of the many excellent Kodak publications, write to Eastman Kodak Co., Sales Service Division, Rochester 4, N.Y. Here are just some of the titles.

Adventures in Indoor Color Slides, 75 cents.

Adventures in Outdoor Color Slides, 75 cents.

Applied Color Photography Indoors, $1.

Basic Developing, Printing, and Enlarging, 50 cents.

Basic Titling and Animation, 75 cents.

Camera Techniques for Professional Photographers, $1.

Color as Seen and Photographed, $1.

Color Photography Outdoors, $1.

Copying, 75 cents.

Darkroom Design and Construction, 75 cents.

Enlarging, 75 cents.

Kodak Color Films, $1.

Kodak Filters and Pola-Screens, 75 cents.

Kodak Photographic Papers, 75 cents.

Magnetic Sound Recording for Motion Pictures, $1.

Negative Making for Professional Photographers, 75 cents.

Photography in Law Enforcement, $1.25.

Precise 35-mm Technique, 75 cents.

Printing Color Negatives, $1.

Processing Chemicals and Formulas, 75 cents.

Professional Printing, 50 cents.

Spiratone [135-06 Northern Blvd., Flushing 54, N.Y.]

All About Close-Up Photography, 35 cents.

Lens Accessories, 35 cents.

Government Publications on Photography

These books may be ordered from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. Refer to catalog numbers when you order and include check or money order payable to Superintendent of Documents. No postage is needed for shipment within the U.S., its possessions, and Canada.

Basic Photography [Air Force Manual 95-1, No. D 301.7:95-1], $2.

Military Standardization Handbook, Glossary of Photographic Terms, [D 7.6/2:25], 70 cents.

Photographer's Mate 3 [No. D 208.11:P 56/3/961], $3.

Photographer's Mate 2 [No. D 208.11:P 56/4], $2.25.

Photographer's Mate 1 & C [No. D 208.11:P 56/5], $2.25.

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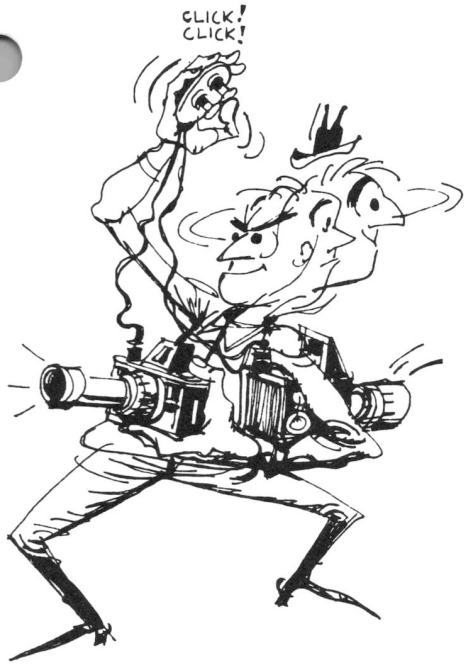

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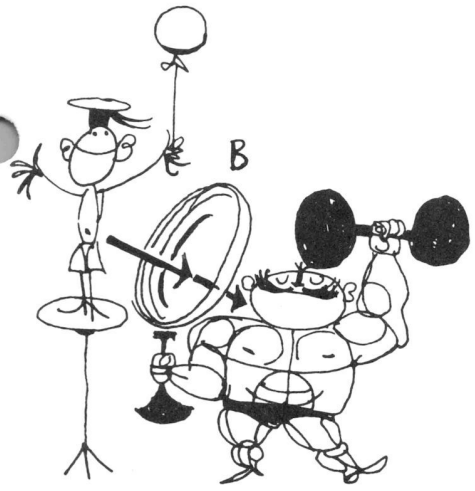

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